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FROM

The Station

BULLETIN 203

DECEMBER, 1902.

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

CHEMICAL DEPARTMENT

**ANALYSES OF SOME OF THE COMMERCIAL FEEDING
STUFFS OF MICHIGAN**

BY

FLOYD W. ROBISON

**AGRICULTURAL COLLEGE, MICHIGAN
1902**

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

ENTOMOLOGICAL DEPARTMENT

**MOSQUITOES AND OTHER INSECTS OF THE
YEAR 1902.**

BY

R. H. PETTIT, ENTOMOLOGIST.



The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
Chatnam, Alger County, 160 acres deeded.

ANALYSES OF SOME OF THE COMMERCIAL FEEDING STUFFS OF MICHIGAN.

FLOYD W. ROBISON, B. S., CHEMIST.

The feeding stuffs of which the analyses are reported in this bulletin were purchased in the open market in various parts of the State by farmers and feeders and samples sent to the station for analysis.

No attempt has been made to make a careful canvass of the State nor to secure samples of all feeding stuffs offered in Michigan markets.

The thanks of the station are due to the persons who have so far interested themselves in the matter as to send samples of the feeds purchased.

Definition of Terms.

There are several technical terms that must be used in the discussion of the composition of feeding stuffs. These terms were defined at some length in bulletin 149 (Report for 1898, page 250), now out of print. A brief definition of these terms therefore follows:

1. *Water*.—All feeds contain more or less water depending on their nature and on the treatment they have undergone. The so-called dry feeds, like hay or cornmeal, will contain from five to fifteen per cent. of water, while corn silage has in every hundred pounds fully eighty pounds of water and a hundred pounds of such roots as turnips may contain ninety pounds of water. Beet pulp, as it leaves the factory, usually has about 93 per cent. of water. It is this water that gives the succulent character to roots, silage, beet pulp and like materials. Just to what degree this succulent character is an advantage has not been fully determined.

2. *Protein*.—The protein or nitrogenous part of the feeding stuff is the part of it which corresponds to the lean meat, the white of eggs, or cheese, in the human dietary. Its distinguishing characteristic is that it is the only part of the material which contains nitrogen. It is, in the North, at least, the most expensive constituent of the feeding stuff and the one in which the grasses and grains of the farm are most lacking.

It is the protein of the food that is used by the system to replace waste muscle and tissue, to supply the casein of milk, and is essential to carry forward the activity of the vital organs.

Experiments almost without number have demonstrated that dairy cows need large quantities of protein in their daily ration, the amounts varying from one and one-half to three pounds, depending on the amount of milk secreted and the size of the cow. Fattening steers, lambs and swine need a less amount per thousand pounds live weight, but even with fattening animals there is need of much more protein than is usually found present in the hay, cornstalks and corn, constituting the ordinary ration for such animals on the Michigan farms. *The commercial feeding stuffs are purchased to supply this lack of protein.*

Green.—Vigorous and productive; ripens early; berries small and seedy this season.

Hilborn.—Vigorous and very productive; fruit of medium size; a reliable market sort.

Idaho.—One of the best late-ripening sorts; fruit of the largest size and good quality; has proved to be a reliable variety at the station grounds, and can be safely recommended for home or market.

Kansas.—The best mid-season variety on trial this season; plants are strong, vigorous growers; fruit of large size and attractive in appearance. A valuable market sort.

Livingston.—One of the newer varieties that is proving itself worthy of a place in the commercial plantation. One of the best late-ripening sorts; bore a full crop of berries of large size.

Mills.—One of the best mid-season varieties; fruit was of large size and attractive appearance, but this variety has the reputation of not standing drouth well.

Smith (Prolific).—Considered a valuable mid-season sort; fruit of large size; quality good; plants only moderately vigorous.

RED VARIETIES.

Cuthbert.—An old, well-known market variety that still holds first place in vigor and productiveness; needs no recommendation.

Early King.—The first variety to ripen this season; fruit of good size and quality; plants only moderately vigorous. Valuable as an early sort.

Golden Queen.—Plants vigorous and usually productive; resembles Cuthbert in form and flavor; excellent for home use, but does not take well on the market.

Hansell.—An early ripening sort, but lacking in vigor and productiveness.

Marlboro.—This variety made the finest showing in the station collection this season. The fruit was of the largest size; ripened over a long season, and held its size well to the end of the season. Somewhat lacking in hardiness, but a valuable sort in some localities.

Miller.—Lacks vigor and productiveness here, but is a valuable market variety in some places.

Phoenix.—A moderately vigorous grower, which made a good showing this season. The fruit was of large size, attractive appearance and ripened over a long season.

Turner.—A vigorous grower, moderately productive of fruit of fair size and very good quality. Very hardy.

PURPLE CAPS.

While we have a large number of varieties of this class of fruit on the station grounds, and nearly all are fairly productive, only a few are worthy of mention, of which Columbian and Shaffer hold first place in hardiness, vigor and productiveness. Emmet and Redfield are good varieties, but do not equal the latter varieties. Columbian and Shaffer are valuable for home use and in markets where they are known.

BLACKBERRIES.

As a whole, the blackberry crop was very good this season. No doubt the good showing made is due to plenty of rain up to and through the time of fruiting. Like the raspberries, the very earliest and very latest varieties brought the best price on the market. Wallace and Minnewaski were the best varieties this season. Early Harvest was the most productive of the early varieties.

NOTES ON VARIETIES.

Ancient Briton.—A strong, upright grower, and quite largely planted for commercial purposes, but here the berries run small, rendering it undesirable.

Early Harvest.—A valuable early market sort, but must have winter protection to get best results.

Early King.—A valuable early market sort, and, like Early Harvest, should have winter protection.

Eldorado.—Very hardy and productive; resembles Snyder in growth of plant, but the fruit runs larger than that variety, and it is more productive here. One of the newer kinds that is considered valuable for market purposes.

Erie.—A very large berry of fine appearance, but lacks productiveness.

Kittatinny.—An old, well-known market sort, but is being largely replaced by other varieties on account of its being especially liable to the attack of red rust.

Knox.—Proves to be valuable here, although reported to lack productiveness; plants are strong and upright in growth; fruit large, attractive and of good quality.

Maxwell.—Plants lack vigor and productiveness. A failure here.

Minnewaski.—The best late-ripening variety on station grounds this season. Plants vigorous and productive; fruit of large size, and ripens over a long season. Valuable market variety.

Nevada.—This variety made a fine showing this season. The fruit was of large size and good quality; ripens late. Valuable.

Ohmer.—Fruit of large size and good quality. Valuable as a late-ripening sort.

Sanford.—Very productive, but the fruit is too small to be valuable.

Snyder.—Considered valuable in localities where great hardiness is required, but does not prove satisfactory here. Fruit is small.

Taylor.—Hardy, vigorous and productive, but fruit is too small to be a profitable market variety.

Wallace.—This has proved to be the very best mid-season variety for home or market. Plants hardy, vigorous and productive. Fruit of large size and excellent quality.

Wilson, Jr.—Plant moderately vigorous and very tender, but in some localities, with winter protection, the most profitable market variety grown. Fruit of large size and very attractive.

CURRANTS.

The currant crop was unsatisfactory this season. The stems were not well filled and the fruit was small and unattractive in appearance. They bloomed very full, but no doubt the cold, heavy rains at the time had something to do with stems not filling out. The Cherry varieties were by far the most profitable this season. While the stems were not well filled out, the berries were very large and attractive and sold for \$1.25 per sixteen-quart crate, while all other varieties ranged from 40 to 60 cents per crate, and hardly paid for the expense of handling them. For the white varieties, there seems to be but little demand, although they are of the best quality for dessert purposes. There is a good demand for black currants, but they do not seem to be popular for commercial planting.

NOTES ON VARIETIES.

Cherry.—While not so good a grower as the smaller kinds, and somewhat subject to the attack of twig borer, its large size and attractive appearance makes it a valuable market sort.

Fay.—Closely resembles Cherry, but bore a better crop of fruit this season. It is even more subject to the attack of twig borer.

Holland.—A vigorous grower, but lacking in productiveness here. Considered valuable for market by some. The plants are invariably infested with plant lice.

Lakewood.—Resembles Cherry, but has proved to be a better grower than that variety. A valuable sort for market.

Lancaster.—A white currant of good quality. Only moderately productive.

London.—Plants vigorous and very productive. Considered by many the most profitable variety grown.

North Star.—A comparatively new variety that made a good showing this season. Plants are upright, vigorous and fairly productive. Has some value as a market sort.

Pomona.—A very good new variety, but as yet does not equal some of the older varieties on trial. Clusters of medium length; fruit medium to large and of good quality.

Red Dutch.—Plants tall and very vigorous; usually productive, but the fruit is too small to be a valuable market sort.

Select.—Of the Cherry class; fruit large and handsome. Valuable.

Versaillaise.—Moderately vigorous and productive; berries above medium size. Of some value as a market sort.

Victoria.—An old, well-known variety. Plants vigorous and very productive, but the fruit is too small to be valuable as a market sort.

GOOSEBERRIES.

ENGLISH VARIETIES.

Chautauqua.—Plants vigorous and productive. Berries very large and of good quality. One of the most profitable varieties on trial.

Columbus.—Made the finest showing of any variety this season.

Plants vigorous and productive; berries of large size. One of the best.

Industry.—Lacking in vigor and productiveness. Berries turn red when ripe. Not desirable.

Keepsake.—Plants vigorous and productive. Berries of the largest size; color greenish yellow. One of the very best for market.

Lancashire.—A vigorous grower and very productive. Berries of large size and good quality, but have the fault of turning red, and this is an objectionable feature in the market.

Orange.—This is the most vigorous grower, and has the finest quality of any variety on the station grounds, but too small for market. Valuable for home use.

Of the American varieties, Downing is by far the best on trial in hardiness, vigor and productiveness. Valuable for market.

CHERRIES.

The cherry crop, as a whole, was very poor this season, especially the sweet varieties; but a number of the sour kinds bore full crops. Montmorency, Weir, King, Ostheimer, Suda and Northwest were the most productive. Of the Duke class, Magnifique, Montrueil and Carnation were best, as were Napoleon, Windsor, Baltavar and Mary Kirtland of the sweet varieties. The cherry seems to sustain greater loss from cold or heavy rains, while in bloom, than any other fruit. Many complaints come to the Station from this locality and different parts of the State of the leaves turning yellow and falling from trees in July. This was not so of the trees on the station grounds, and it is evident from results obtained here that two or three thorough applications of Bordeaux mixture is effectual in holding the leaves on the trees. Commercially, no satisfactory results were obtained from the sweet kinds; but with the sour varieties the prices advanced with the season, Dyehouse and Richmond selling for \$1.00 per crate; Montmorency, \$1.25 per crate; and Suda, Ostheimer, Northwest and Wragg, one week later, at \$1.40 per crate. While without doubt Montmorency is the most profitable variety grown at present, with the large acreage already out, it would seem advisable to plant more of the later kinds.

MORELLOS.

Brusseler Braune.—Tree an upright, vigorous, handsome grower. Fruit very large, attractive and of excellent quality. A fine late cherry, but has proved unproductive here.

Dyehouse.—If anything, ripens a little in advance of Richmond, but is not so vigorous as that variety, although fully as productive.

King.—Tree vigorous and productive; ripens with Richmond, and it seems fully equal to that variety.

Minnesota.—A late-ripening variety of some value for market. Fruit above medium in size; color dark red; quality good.

Monarch.—Supposed to be a new variety, but seems identical with Montmorency here.

Montmorency.—The most profitable and most largely planted sour cherry.

Northwest.—Trees low, spreading, dwarfish in habit; lacking in vigor, but very productive. Valuable as a late ripening sort.

Ostheimer.—Seems identical with Suda, and with that variety the most profitable late-ripening sort. Fruit medium to large; dark red; heart-shaped.

Richmond.—One of the most profitable early market varieties grown. Vigorous and productive.

Suda.—Very productive. Fruit large, dark red, heart-shaped; ripens late in the season. One of the best.

Weir (No. 2).—A strong, vigorous grower; very productive. Fruit large, but a little light in color; ripens a little in advance of Richmond and excels that variety. A valuable early market sort.

Wragg.—Very productive. Fruit large, dark red, and ripens late. Valuable as a late market sort.

DUKES.

Carnation.—One of the best Dukes on trial. Tree vigorous and fairly productive. Fruit large, dark red and of very good quality.

Magnifique.—The best Duke on trial this season. Fruit of large size and good quality; rather light in color. Valuable as a late-ripening variety.

Montrueil.—The very best all-round Duke. Fruit very large and of the best quality; color dark, rich red. Tree vigorous and productive. Valuable for home or market.

White Bigarreau.—So named, but between the Duke and Morello in type. Received from the Division of Pomology in 1895. Tree a rather slow grower, forming a low, round, bushy head. Fruit large and of good quality; color very light red, with a shade darker on one side; very tender, juicy, with sprightly subacid flavor. Requires further trial.

HEARTS AND BIGARREAUS.

Badacsony.—Of Hungarian origin. Tree lacks vigor and is only moderately productive. Fruit large, very firm; dark, rich red in color; quality only fair. Not desirable.

Baltavar.—Fruit large, firm and attractive in appearance. The most promising of the three Hungarian varieties—Badacsony, Baltavar and Mednyansky—received from the Division of Pomology.

Cleveland.—A very strong grower and quite an abundant bearer. Fruit large; light yellow, shaded with red; quality fair.

Ida.—A very large, light-colored cherry of very good quality. Rather tender for distant markets. Valuable as an early sort for home use.

Mednyansky.—Of Hungarian origin. A moderately vigorous, spreading grower. Fruit medium to large; very dark, almost black, in color; quality only fair. Too low in quality for home use, and not quite productive enough for market.

Napoleon.—Considered one of the most profitable market varieties grown. Vigorous and very productive. Fruit of large size and attractive in appearance. Bore the heaviest crop of any variety of sweet cherries on trial this season.

Plymouth Rock.—A new variety that as yet does not excel other older varieties. Trees vigorous and productive. Fruit of medium size and good quality.

Rockport.—Of large size, attractive in appearance and very good quality. Moderately vigorous and productive.

Yellow Spanish.—An old, well-known variety that is still a valuable sort for home use or market.

Windsor.—Tree vigorous and productive. Fruit large, heart-shaped; color dark red; quality very good. One of the most valuable varieties for home or market.

Wood.—A very good early variety. Fruit of medium size; color light yellow, shaded with red; tender for distant market, but valuable for home planting.

PEACHES.

There was a heavy crop of peaches. The fruit was large but not so good in quality, and somewhat lacking in color, especially the late-ripening varieties, which was due no doubt to excessive rains and lack of sunshine.

SPRAYING.

A comparative test was again made to determine how late in the spring the spraying can be done for "leaf-curl," and satisfactory results secured. One-half of the trees of each variety were sprayed April 1, with two pounds of copper sulphate to fifty gallons of water, and the remainder were sprayed, April 15, with the same solution (except one tree in each block left unsprayed). The following results were noted: All trees sprayed April 1 were free from "leaf-curl." Of the trees sprayed April 15, a large number were quite badly affected, and all trees left unsprayed were so badly injured that they lost nearly all of their foliage.

For the control of brown rot, after the fruit had set, all trees were sprayed with a weak solution (three-fifths strength) of Bordeaux mixture and arsenite of lime. Later, trees of the earlier ripening varieties were sprayed with a solution of three ounces of copper sulphate to fifty gallons of water at intervals of ten to fifteen days, until the fruit ripened. The result was that very little rot made its appearance. Amsden, Triumph and Barnard being slightly affected, and the later peaches not at all. It is very necessary to do the spraying thoroughly to obtain the best results.

PRUNING.

Late in the fall of season of 1900, a number of trees were pruned to determine whether there would be any injurious effects on fall-pruned trees. There was no difference noticeable the following season, but when the trees were pruned this year it was noticed that the wounds, from heading back and thinning out branches, had dried out, and in some instances killed back instead of healing over, as they do if pruned in the spring, when the sap is flowing.

In view of this fact, it would seem that the best time to prune is early in the spring, before or at the time the sap begins to circulate.

THINNING THE FRUIT.

A thinning test was started this season, to last over a period of three years. Of one lot, one tree was thinned to eight inches; one was thinned to four or five inches, and one tree was left unthinned. Of the other varieties, one tree was thinned to eight inches and one tree unthinned. It was noted at the end of the first season's test that all trees severely thinned were much thriftier and their foliage much healthier, and did not fall from the trees as early in the season as on unthinned trees; that peaches taken from the thinned trees sold for nearly double as much as those from unthinned trees.

The varieties chosen for the test happened to ripen at a time when there was a good demand, otherwise peaches from unthinned trees would have been unsalable. From a commercial standpoint, the benefits from heavy thinning were very apparent.

MARKETING.

Of the yellow varieties, Engle Mammoth is the most profitable variety on station grounds, Salway ranking next, with Ford New, Kalamazoo, Brunson, McCollister, Smock, Willett and Gold Drop following closely. The Elberta trees have been removed, and it was not considered in the above statement. Although somewhat tender in fruit bud and rather inferior in quality, this variety is in large demand and commands the highest market price, and it is considered one of the most valuable varieties for commercial planting. Smock has usually been a very profitable sort, but this season it was far from satisfactory, owing to the conditions at the time of ripening.

Much depends upon the size of the fruit and the packing. As a rule, white varieties have not been satisfactory, and many growers have removed them from their orchards, while very few are being planted; and yet the better white varieties grown at the station grounds, well packed in open-slat, one-fifth bushel baskets, sold for a higher price than many of the later yellow varieties on the Chicago market.

NOTES ON NEW VARIETIES.

Advance.—Size medium to large; color white, with red cheek; quality fair; ripens the middle of August. Will require further trial. Semi-cling.

Banner.—Ripened a few fruits for the first time, this season, from trees planted in 1899. Of medium size; yellow, with slight red cheek; ripens with Smock, but is of better quality than that variety. Will require further trial.

Capital.—Size medium to large; color yellow, with very faint tinge of red; resembles Smock somewhat and ripens with that variety. Fruit is dry, mealy and not so good in quality.

Clifton.—Ripened a few fruits this season from trees planted in 1900. A white-fleshed peach of medium size and fair quality. Ripe August 23. Freestone.

Delaware.—A handsome, large-sized, white-fleshed peach of good quality. Ripens in early September. It is doubtful if it proves of value, coming at that time and being white-fleshed.

Emperor.—A medium-sized, yellow-fleshed freestone of only fair quality. Ripens with Smock. Requires further trial to determine its value.

Eureka.—Ripened a few fruits for the first time, this season, from trees planted in 1900. Color white, with red cheek; form long, compressed, of Elberta type; texture tender, juicy; quality good. Semi-cling. Ripens just before and with Lewis.

Sneed.—The earliest-ripening variety tested. A semi-cling, medium-sized, white, of fair quality. Of some value for local market.

Waddell.—The most promising new white-fleshed peach. Of medium to large size; color creamy white, with handsome red cheek. Rather tender, but of very good quality. Ripens just before Lewis.

Zea.—Ripens with Waddell and is large and attractive, but is not as good in quality nor as productive as that variety.

Wark.—Resembles Triumph in form, color and quality, and is also semi-cling. Ripened a few fruits from trees planted in 1900; a few days later than Triumph, but on older trees will probably ripen with that variety. Will require further trial.

NOTES ON OLDER VARIETIES.

Allen.—Of large size and good quality. Resembles Jacques Rarieripe, but lacks the productiveness and hardness of that variety.

Amsden.—It is no doubt desirable to have a few trees of this variety for home use, but from a commercial standpoint it is a damage to the peach industry of Michigan. It comes in competition with the fine yellow freestones from the South, and every year the market bulletins quote them as "the hard, green, white clingstones of poor quality from Michigan." It rots badly on the trees and in transit to the market.

Barnard.—An old, well-known variety at one time very largely planted for commercial purposes; ripens with Engle Mammoth, but is far less valuable than that variety.

Bequette.—A white peach of the Elberta type, ripening with that variety. Of the largest size, vigorous and productive. The most desirable white peach at that season.

Bishop.—Ripens just before and with Lewis, and is a larger and finer-looking peach. A desirable variety.

Brunson.—Resembles Kalamazoo, although a distinct variety. Ripens just before and with that variety, and is fully equal to it.

Champion.—A valuable market variety. Of the largest size and best quality, but too tender for long-distance shipping. Color creamy white, with handsome red cheek; season, early September.

Connett (Southern Early).—A large, handsome, white peach. Ripens, if anything, a little ahead of Lewis. Is entirely free from rot and is to be preferred to that variety. Valuable as an early market sort.

Crothers.—A medium to large, attractive, white-fleshed freestone peach of good quality; ripens just before Smock. Valuable where a white-fleshed variety is desired.

Ede (Captain).—Resembles Elberta in shape, color and flavor but is smaller, ripens a few days earlier and is not as valuable as a market sort.

Engle Mammoth.—The very best peach of its season. Of large size, attractive appearance, best quality, and very productive.

Ford, New.—Ripens with and resembles Engle Mammoth, and seems to be fully equal except in quality.

Ford 1.—An attractive, white-fleshed peach of good quality; seems worthy of a place in the commercial orchard; ripens just before Lewis; is entirely free from rot and very productive.

Ford 2.—A late-ripening peach of large size and good quality. Unproductive; valueless.

Ford 3.—A late-ripening, white-fleshed peach of poor quality. Not valuable.

Ford Red.—An attractive, white-fleshed peach ripening in early September; productive, but less profitable than the yellow varieties ripening at that time.

Gold Drop.—Hardy and productive to a fault. It has been one of the most profitable varieties grown, but is now less highly esteemed except when heavily pruned and thinned.

Greensboro.—Ripens with Rivers and does not excel that variety. Not particularly desirable.

Gudgeon.—A very large, late, white peach of low quality. Not desirable.

Haas.—Ripens with Hale and is practically identical with that variety.

Husted (101).—A medium to large peach resembling Chili in appearance, but ripens a week to ten days earlier. Of some value as a market sort; a good record here.

Ice Mountain.—Of no value here; always sets a full crop but have been frozen until this season when a number of baskets were picked on December 1. Of medium size; color, clear, rich yellow; a freestone; of poor quality. The fruit kept in the cellar until January.

Iron Mountain.—A late-ripening white peach of low quality. Worthless.

Jersey Yellow.—Of Smock type and season, and no improvement on that variety. Inclined to be unproductive. Valueless.

Juno.—A late-ripening yellow clingstone of poor quality; ripens with Smock. Not valuable.

Kalamazoo.—A very profitable market variety which should be largely planted. Well liked by canning factories. Vigorous and usually productive.

Lafayette.—Of medium size and attractive in appearance. Bearing at the time it does, with Hills Chili, it is not likely to prove of much value.

La Fleur.—An attractive fruit; ripens with Chili, but is less productive than that variety.

Lemon Free.—A large, greenish-yellow peach; ripens with Smock, not as attractive in appearance but harder and more productive. Considered by some a valuable late market variety.

Lewis.—Has been a very profitable market sort, but rots badly.

Longhurst.—Of the Chili type and season. Seems to be an improvement, being smoother, larger and higher colored.

McCollister.—Of the largest size, attractive in appearance and of good quality; ripens just before Smock and is a valuable market variety.

New Prolific.—Bore a full crop of fine-looking peaches this season; ripens with Engle Mammoth; equaled that variety in every way this season except in productiveness.

Oceana (Husted 130).—One of the newer varieties; ripens just before Engle Mammoth. The fruit is large, yellow with red cheek; of very good quality. Seems to be a valuable variety for market purposes.

Red Cheek.—An old, well-known variety, well spoken of by some growers. Of large size; color yellow, highly colored; of good quality. Ripe September 22. Fairly productive.

Salway.—By far the best variety of its season on the Station grounds; large, yellow, with red cheek, and of very good quality; usually productive. A valuable market variety.

Smock.—An old, well-known variety. Beer's Smock, Hance Smock and Smock are identical here.

Stevens Rareripec.—A large-sized, handsomely colored white peach of good quality; ripens in late September. Valuable where a peach of that class is desired.

St. John.—Of large size; very handsomely colored and of excellent quality. Considered by many as a valuable market variety. Lacks in productiveness here.

Triumph.—Hardy, vigorous and very productive, inclined to over bear; requires heavy thinning and pruning or the fruit will be small. Inclined to rot. It is a semi-cling but can be safely recommended for planting on a small scale.

Willett.—Practically the same as Longhurst; of the Chili type; hardy and very productive. Fruit highly colored, of medium to large size and very good quality.

Worthen.—Of large size, handsomely colored, and of excellent quality. Of the Crawford type, but seems to be more productive than that class usually is.

PEARS.

The pear crop this season was a heavy one and exceptionally free from worms and scab. In spraying they received the same treatment as the apples. Fancy Duchess and Bosc brought the highest price of any varieties grown on the Station grounds, selling for \$1.35 per bushel in Milwaukee. The opinion of most of the pear growers in this locality is that Bartlett still has the lead, and canning factories will take nothing else when they can get them. Bosc, while not so largely planted, nor so well known, commands the highest market price. Does not come in bearing as early as some varieties, but is a heavy and an annual cropper as the trees increase in age. As to Kieffer, opinions vary greatly. While many consider it one of the most profitable varieties grown, there are many others who do not think so favorably of it; but while it may not be quite so largely planted in the future as in the past, it has come to stay and will see its seasons of great profitableness.

NOTES ON VARIETIES.

Angouleme (Duchess).—One of the most profitable late fall market varieties. Of the largest size; quality good; color yellow.

Anjou.—A fine late fall pear, but slow in coming into bearing. Color yellow with a brownish-red cheek. October and November.

Ansault.—An early and an abundant bearer. Ripens just before Sheldon and resembles that variety. An excellent variety for home use.

Barry.—A winter pear of large size but rather low quality. Color,

cinnamon russet; attractive in appearance; seems to lack productiveness.

Bartlett.—An old standard variety; well known.

Bloodgood.—A valuable early ripening variety of medium size and excellent quality. Color yellow with brownish-russet blotches. Ripens in August.

Bosc.—Of large size; very best quality and a handsome golden-russet color. Rather slow in coming into bearing, but considered a valuable late fall market variety.

Boussock.—A large pear of good quality. Ripens in early September.

Dana Hovey.—Equals Seckel in every way. Ripens later than that variety and is worthy of a place in every garden.

Drouard.—Ripened its first fruit this season from six year old trees. Form obovate, pyreform; color yellow, sprinkled with many russet dots; texture firm, breaking, granular; quality only fair. Season December-March.

Early Duchess.—A new variety. Resembles Angouleme in form and color, but has a much smoother surface. Ripens three weeks earlier. Bore a full crop this season and promises to be very productive and valuable.

Elizabeth (Manning).—A handsome little dessert pear ripening in the middle of August. Tree is a fine, shapely grower and very productive.

Esperen.—A late-ripening variety of rather small size and of only fair quality. Not desirable.

Fitzwater.—Size medium to large; color yellow with russet markings; quality good. Ripens in October; bore a heavy crop this season, and should it continue to do so, will be a valuable variety for market.

Flemish Beauty.—Considered by those who do not spray as worthless on account of its scabbing and cracking, but on the Station grounds is a profitable market variety.

Fred Clapp.—Of medium to large size; yellow with brown patches; of good quality and productive; valuable fall variety for market or home use.

Gansel Seckel.—Bore a full crop this season; fruit small, irregular; of good quality but not rich; unattractive in appearance and not promising for market.

Giffard.—Of medium size, good quality and productive. Ripens in early August and seems valuable for market. Color greenish yellow with brownish red cheek.

Groveland.—A late fall variety of large size and good quality. Resembles Anjou in color and form. Unproductive as yet.

Howell.—An early and abundant bearer. Medium to large size; color yellow; of fair quality; a valuable market variety.

Kieffer.—Hardy, vigorous and very productive of fruit of good size and attractive appearance. Quality low, but a good keeper and a long distance shipper. A standard variety.

Kraus 41.—Size medium; color yellow; quality low. Ripens late August. Not valuable.

Lawrence.—A late fall and early winter variety; color greenish yellow with russet markings; quality very good. Grown to some extent for market.

Longworth.—Tree vigorous and productive, but too poor in quality to be valuable.

Mt. Vernon.—Tree vigorous and productive of fruit of medium size and fair quality; color yellow, overlaid with cinnamon russet, brownish-red cheek. Ripens in late October. Of value as a market sort.

Pitmaston.—Of very large size and good quality; color clear yellow, very attractive in appearance. A desirable market variety if it proves productive. Ripe October 15.

President.—Of very large size and good quality. Not as attractive as Pitmaston. Color yellow, with many russety dots and markings. If productive with its large size will be a valuable market variety.

Reeder.—A smooth, fair-growing pear, resembles Howell, but ripens in late October. Of good quality; medium size, and bore a heavy crop this season. A promising variety for market.

Rostiezer.—Of small size and rather unattractive appearance but of excellent quality. A fine dessert pear. Season late August.

Rutter.—Of large size; color yellow, dotted and netted with russet; quality good. Bore a full crop this season; a promising market variety. Ripe October 15.

Seckel.—An old well-known variety; valuable for dessert and market; bore a heavy crop this season and fruit was unusually large in size.

Sheldon.—Of medium to large size; color russet; form round; quality excellent, tender, very juicy, rich. Considered a valuable fall variety for home or market.

Souvenir (du Congress).—Of the largest size; clear yellow; good quality, has a Bartlett flavor. Bore a full crop this season. Promising as a market sort.

Tyson.—Of small size and excellent quality; pyriform; color yellow, russeted. Trees vigorous, but are 14 years old and bore a few fruits for the first this season. Not promising.

Winter Nelis.—Fruit small; color yellow, russeted; texture tender, melting, buttery, with a rich, sweet flavor; quality good. Considered one of the best winter varieties.

NEW VARIETIES.

Conference.—Ripened a few fruits for the first time this season on four-year-old trees. Fruit of medium to large size, obtuse pyriform; color greenish yellow with russety blotches and markings; flavor sweet, rich; texture tender, melting, very juicy and of the highest quality. Promising but requires further trial. Ripe October 5.

Kraus 18.—Received from C. F. Kraus, N. Y., in 1895. Bore a fair crop of fruit for the first time. Size medium to large, with a very handsome red cheek; form obovate, obtuse, pyriform; flavor rich, vinous, perfumed; texture tender, buttery, melting; quality very good. Promising, requires further trial. Ripe September 5.

Louise (Bonne de Jersey).—An old, well-known variety. Ripened a number of fine specimens on trees planted in 1900. Size medium to large; color greenish-yellow with brownish-red cheek, and sprinkled with many reddish dots; quality good. Trees quite productive. A valuable market variety.

Garber.—Bore a full crop for the first this season on trees planted in 1892. Of the Kieffer type in texture, color, quality and growth of trees, but has lacked the productiveness of that variety. Considering the length of time that it has taken this variety to get into bearing, it does not seem a promising variety. With its low quality it would need to be an early and an abundant bearer to make it a profitable market variety.

Magnate.—Ripened a few perfect specimens for the first this season on trees planted in 1898. Size medium to large; form obtuse-pyriform; color yellow with red cheek; flavor vinous, pleasant; texture tender, juicy, melting; quality very good. Ripe October 1. Promising, but requires further trial.

PLUMS.

There was a good crop of plums this season and they were quite free from rot. The trees were sprayed early in April with copper sulphate, two pounds to fifty gallons of water. Immediately after the blossoms had fallen, they were sprayed with Bordeaux mixture and arsenite of lime, and this was repeated at intervals of six to ten days until they had received four applications, after which weak solutions of copper sulphate (three ounces to fifty gallons of water) were applied every week until the fruit began to ripen.

THINNING.

One tree each of a few varieties were thinned this season to determine, if possible, the value from a commercial standpoint and in helping to control the brown rot. The fruit was thinned so as to leave as much fruit as was possible on the tree, and yet not come in contact when fully matured, with the following results: The fruit was much larger where thinned and at all times brought a higher price from being such, and it certainly rotted worse where left in large bunches than when thinned. It was also noticed that the trees did not drop their foliage as early in the season. Observations will be taken next season at the time of the blossoming and setting of the fruit to determine if there be any further effects.

MARKETING.

To determine if there are any points of commercial value in the use of different kinds of packages for shipping this fruit, the following test was made on the same day and to the same commission house: The following packages were packed and shipped (variety Red June), one sixteen-quart case (the fruit in quart boxes), two one-fifth bushel baskets, and one four basket crate, such as is used for tomatoes. By actual measure, the two one-fifth bushel baskets equaled the one four-basket crate, with a difference of five quarts between those packages and the sixteen-quart case. The following sales were made: One dollar for sixteen-quart case, one dollar for four-basket crate, and 35 cents each for the two baskets, or 70 cents for the two one-fifth bushel baskets. Thus the sixteen-quart case and the two one-fifth bushel baskets brought the same price per bushel of fruit, while in a four-basket crate it brought nearly fifty per cent more, a difference of seventy-five cents per bushel in favor of the four-basket crate. The fruit in all of the packages was first-class.

Observations made with other fruits would indicate that the four-basket crate is especially adapted to first-class fruit, while the second-class fruit is best handled in the one-fifth bushel basket, also that small Damson plums are best handled in the sixteen quart crates. Red June is proving to be one of the most profitable varieties on the Station grounds on account of its earliness and productiveness. The Damson plums brought nearly double the price of other varieties.

MARKET VARIETIES.

European.

The following varieties are proving to be the most profitable varieties on the Station grounds: Bradshaw, Black Diamond, Kingston, Grand Duke, Lombard, Monarch, Fellenberg and Giant Prune.

Japan Varieties.

Red June, Abundance, Burbank and Satsuma.

NEW VARIETIES.

America.—A native plum that ripened a few fruits from trees planted in 1900. Of small size; form roundish-oblong; color light red; texture tender, juicy; flavor sweet, bitter next to skin and pit; of only fair quality and a clingstone. Coming as it does with fine European varieties, it does not seem promising. Ripe August 20.

Clyman.—Originated on the farm of Mrs. Clyman in Napa valley, California. A European plum of medium size, roundish inclining to oblong; color blue with a light blue bloom; texture firm, moderately juicy; flesh yellow; quality good. Ripe August 4. Promising if it proves productive.

Splendor.—Of medium size; of prune type, long, oval, compressed with neck, suture indistinct, cavity broad, of medium depth; color blue with blue bloom; flesh yellow, firm, only moderately juicy; sweet, rich, mild; quality very good; freestone; pit long, narrow, flat. Ripe September 5.

Muscat Free.—Ripened a few fruits for the first this season. Is of the German Prune type; long, oval, compressed, sometimes with neck; of medium size; color dark blue with blue bloom; texture firm, rather dry; flavor rich, sweet; color of flesh greenish-yellow; quality good. Ripe September 5. Requires further trial.

Quetsche Freestone.—Of the German Prune type. Bore a full crop this season. Fruit below medium in size; color dark blue with thick blue bloom. Form long, oval, compressed; suture distinct; texture firm, juicy with brisk sub-acid flavor; flesh yellow; quality fair. Ripe September 13. Promises to be productive but of rather small size. Requires further trial.

NOTES ON OLDER VARIETIES.

European Plums.

Agen Prune.—Of medium size, dark purple; quality very good. Season early September. Moderately productive but not quite large enough for best market results.

Arch Duke.—Of large size and excellent quality. Ripens a few days earlier than Grand Duke, but is less productive.

Arctic.—A small to medium, dark blue plum of fair quality; unproductive. Not valuable.

Aubert.—Practically identical with Yellow Egg. Moderately productive. Valuable for market and home use.

Bavay.—A medium-sized greenish-yellow plum of the very best quality. Valuable for home or market. Ripens in late September.

Bradshaw.—Very large, reddish-purple, of good quality. Bore a heavy crop of fine plums this season. Ripe middle to last of August. A valuable variety for home and market.

Burbank No. 7.—Of medium to large size; yellow; of excellent quality. Tree a vigorous grower, but is rather unproductive. Ripens in late September.

Coe (Golden Drop).—A very large plum of good quality. Ripe late September. Lacks productiveness.

Czar.—A medium-sized, dark blue plum of fine quality, but unproductive.

Black Diamond.—Practically identical with Kingston, and with that variety, one of the most profitable kinds on the station grounds. Very large, blue black, handsome, rather tart for dessert purposes, but a fine canner; very firm and productive. Quite free from rot.

Fellenberg (Italian Prune).—Tree low, spreading, productive; fruit long, oval, one side enlarged; suture distinct one-half around; color dark blue or black; flesh greenish-yellow; moderately juicy, sweet. Ripe last of August. Valuable for home or market.

French Damson.—Somewhat larger than Shropshire Damson, and brought a higher price, but as yet is rather a shy bearer.

Giant Prune.—Bore a heavy crop of large, attractive fruit this season which sold well; quality good. Until this season had not been very productive.

Grand Duke.—Very large, attractive; very firm; nearly free from rot. Being very productive and ripening late, this plum is especially valuable as a market variety.

Kingston.—Very large, blue black, attractive and very productive. Excellent for market planting.

Lincoln.—A very large plum of good quality. Ripens in early August. Valuable for home use, but rather tender for market.

Lombard.—Probably more largely planted in Michigan than any other variety. Is in demand for canning purposes. Quite subject to rot.

Monarch.—A large, dark blue, handsome plum. One of the latest ripening and most profitable plums. An early and abundant bearer.

Murdy.—Of large size, handsomely colored and very good quality. Tree rather a slow grower. Ripens in early September. Moderately productive. A good home or market variety.

Shropshire Damson.—Very small, brings the highest market price. Largely grown and a valuable market variety.

Spaulding.—A medium-sized, greenish-yellow plum of good quality; moderately productive. An excellent variety for home use. Ripens in late August.

Victoria.—Vigorous, very productive, of large size, handsome appearance and good quality. This variety, and Lombard, rotted worse than any other, especially on trees unthinned.

White Queen.—Of large size; color whitish-yellow, mottled with red, and well-covered with a whitish bloom; tender, juicy, of very good quality. Ripe August 22. Lacks productiveness as yet.

Japan Plums.

Abundance.—One of the best known varieties and a valuable early market sort. Ripens ten days later than Red June. Very productive.

Babcock.—A medium to large plum of attractive appearance; color yellow, overlaid with reddish-purple; quality fair. Ripens a few days later than Burbank. Requires further trial.

Berckmans.—Of large size; color dark red, with many yellow dots; quality low. Ripens with Burbank, but is far from being equal to that variety here, as yet.

Burbank.—Vigorous and very productive. When well thinned, large and attractive in appearance; quality good. A better shipper than Abundance. One of the best Japan varieties on trial.

Hale.—Of medium size; color pale yellow; texture tender, very juicy; flavor sweet at first, but bitter, unpleasant next the skin and pit.

Maru.—Of medium size; quite productive, but too low in quality to be valuable. Not desirable.

Ogon.—A large-sized, clear yellow, early ripening plum of rather low quality; unproductive. Not valuable.

Red June.—The most profitable early-ripening plum on trial. Begins to ripen ten days before Abundance, and lasts until that variety comes on the market. Of medium size; color clear red; quality good. Productive and entirely free from rot.

Satsuma (Blood Plum).—Of large size and attractive in appearance; color dark reddish-purple, with dark purple flesh. Tree vigorous, upright, spreading grower and an abundant bearer. A valuable variety for culinary and market purposes.

Yosebe.—The earliest ripening variety on the station grounds. A small red plum of poor quality. Lacks productiveness. Not valuable.

GRAPES.

The crop of grapes, taken as a whole, was light although most of the standard varieties made a good showing. Among the best were Campbells Early, Delaware, Diamond, McPike, Worden, Jessica and Guinevra. Of the Rogers hybrids and other crosses, Agawam, Iona, Jefferson, Vergennes and Ulster made a good showing. A small amount of anthracnose and rot made its appearance on a few varieties, but all kinds were entirely free from mildew. The Delaware is one of the most profitable varieties on the station grounds; the small four-pound baskets selling for the same price as the eight-pound baskets of large blue grapes.

NOTES ON VARIETIES.

Agawam.—Bore a fine crop this season. Fruit large; light red and of fine quality. It sometimes mildews badly and lacks in productiveness. Desirable for home use.

Brighton.—A well-known grape of the best quality. Valuable for home or market.

Campbell.—One of the newer varieties of the Concord type. Ripens two weeks before that variety and this year was more productive. The

bunches and berries are large and hang on the stem long after ripening. Quality very good. Valuable for home and market.

Colerain.—A white Concord seedling; vigorous and moderately productive; quality very good.

Concord.—The most valuable market variety. Does not do as well as Worden here.

Delaware.—For a number of years this well-known variety has been quite productive and it is certainly one of the most valuable varieties on trial. Excels both for market and dessert purposes.

Diamond.—A white grape of very good quality. Ripens just before Concord. The vine is vigorous and more productive than Niagara. Valuable for home or market.

Diana.—A late ripening variety and a long keeper; color light red; quality good. Lacks productiveness.

Duchess.—White, of good quality; keeps well. A good home variety.

Empire State.—A white grape of very good quality. Vine vigorous, moderately productive. Valuable for home use.

Esther.—A white grape of fair quality and attractive appearance; quite productive; bunches usually of good size and well filled. Ripe October 1.

Guinevra.—A white grape received from C. Engle of Paw Paw. Made a good showing this season. Vine vigorous and productive. Bunches large, compact, of very good quality. Valuable for home and market. Ripens with Concord.

Hosford.—A black grape of fair quality. Ripens early but is unproductive. Not desirable.

Iona.—A late ripening, red grape of fine quality; quite productive but ripens unevenly. Valuable for home use.

Isabella.—A late ripening black grape of good quality; unproductive. Not valuable here.

Jefferson.—Bore a full crop this season. A late ripening red grape of fine quality. Keeps well; valuable for home planting.

Josselyn 5.—Color white; quality good; quite productive. Ripens in late September.

Josselyn 9.—A dark grape of low quality. Worthless.

Josselyn 10.—Color black; unproductive. Not valuable.

Lyon.—Vigorous, moderately productive; color white; of fair quality. Not valuable here.

McPike.—Vine vigorous and quite productive. A seedling of the Concord. Ripens a few days earlier but does not equal that variety in size of bunches and berries.

Moore Early.—An early ripening black grape of good quality. Rather unproductive.

Moyer.—A small, dark red grape of good quality, but is too unproductive to be valuable.

Niagara.—Well known and more largely planted than any other white grape. Valuable for home or market.

Pocklington.—A well-known white grape which made a good showing here this season. Ripens in early October.

Salem.—A large red grape of fine quality. Rather unproductive. Valuable for home use.

Telegraph.—Moderately vigorous, very productive. Bunches small, very compact. Color black, quality poor.

Triumph.—Vines vigorous and very productive of bunches of the largest size and attractive appearance. Color greenish-yellow; quality very poor. Ripens late.

Ulster.—Vine moderately vigorous, very productive; inclined to overbear and not ripen its fruit well. If one-half of the bunches are pinched off early in the season, the results will be more satisfactory. Bunches small to medium in size, compact; color red; quality fine. Valuable for home use.

Vergennes.—A late ripening red grape of good quality; moderately vigorous and quite productive; somewhat subject to anthracnose. Valuable for home use.

Worden.—One of the most profitable varieties on trial. Vine hardy, vigorous and productive. Ripens a few days earlier than Concord and excels that variety in productiveness and quality.

APPLES.

The apple crop was very good this season. One-half of the trees were sprayed early in the season with copper sulphate, two pounds to fifty gallons of water, and the remainder were sprayed just before the blossoms opened with Bordeaux mixture, as a comparative test in controlling the scab of apples and pears. The results were not as satisfactory as in former tests, as but little difference could be seen in amount of scab on trees sprayed early and those sprayed just before blossoms opened. In past seasons, more beneficial results were noted on trees sprayed just before blossoms opened, than those sprayed earlier. All of the trees were sprayed with Bordeaux and arsenite of lime, within a week after blossoms had fallen, and, at intervals of ten to fifteen days, two more applications were made. As a whole, the results of spraying for scab and codling moth were satisfactory as the apples were unusually free from worms, and while a few varieties were somewhat affected with scab, most of them were absolutely free from disease. There was no difference noticeable in amount of wormy fruit on trees sprayed July 25 and August 5, for the control of the later broods of codling moth, and those sprayed earlier. The fruit sprayed August 5 and picked October 10 had to be brushed with cloth before it was salable which, of course, is an objectionable feature in late spraying. Oldenburg and Jonathan brought the highest price on the market this season.

NOTES ON NEW VARIETIES.

Barry 5.—Oblate, conical, irregular; medium size; yellow with russet markings; flesh firm; quality rather low. Season October to December. Requires further trial.

Blue Anis.—Below medium in size; form oblate-conical; color yellow, striped and splashed with light and dark red, with thin blue bloom; flavor mild; quality fair. Requires further trial.

Buckskin.—Of small size; roundish-conical; yellow with light red blush; mild sub-acid; quality good. November to March. Not promising.

Egyptian.—Of medium size; oblate, irregular; clear, deep yellow; firm, fine grained, moderately juicy; flavor sub-acid; quality fair to good. December to April. Requires further trial.

Flory Bellflower.—Medium to large size; form roundish-conical; color rich yellow, with minute raised russet dots; flavor sub-acid, moderately juicy; quality good. October and December.

Gideon Sweet.—Of medium size, roundish-oblong; color yellow, striped and splashed with red; mild not distinctly sweet; firm, fine grained, not juicy. November to March. Requires further trial.

Glowing Coal.—Of large size; roundish inclined to oblate; color yellow, overlaid, striped and splashed with red; resembles Gravenstein in both fruit and growth of tree. Season middle of September. Will be valuable if it proves productive.

Greenville.—A seedling of the Maiden Blush and resembles that variety somewhat; of medium size; yellow with red cheek; firm, crisp, juicy, fine grained with mild sub-acid flavor almost sweet; quality very good. November to March.

Hamilton (Black).—Above medium in size; roundish, irregular, somewhat ribbed; yellow, overlaid and splashed with reddish-purple; tender, breaking, juicy, sub-acid; quality good. September and October.

Hungarian.—Medium to large in size; oblong inclining to conical; color yellow, with dark red blush on side exposed; attractive in appearance; firm, fine grained, breaking with mild, almost sweet flavor; quality very good. Season December to March. Promising. Received from Division of Pomology.

Kraus.—Of large size; form oblate-conical; color yellow with faint tinge of red on the side exposed to sun; firm, crisp, juicy; flavor sub-acid; quality fair. November-March.

Lady Sweet.—Above medium in size; oblong-conical; color yellow, striped and splashed with red; flavor sweet, rich; firm, fine grained; quality very good. November to February.

Looker (crab).—The latest ripening crab-apple tested. Of medium size; oblong; color yellow, washed and striped with red; flavor brisk, spicy, sub-acid; firm, crisp, juicy; quality very good. Season late September. Promising.

McLellan.—Of medium size; roundish oblate-conical; color yellow, striped and splashed with red; flavor, mild sub-acid; crisp, tender, juicy; quality good. Season December to March.

McMahon (White).—Of large size; roundish to oblate-conical; color yellowish-white, very handsome appearance; tender, fine grained, with brisk, high flavor; quality best. October to January. Promising.

Mexico.—Medium in size; form roundish-oblate; color yellow overlaid with light and dark red; tender, fine grained, with mild, pleasant flavor; quality fair. Ripe September 1.

Nyack (Pippin).—Of medium to large size and attractive appearance; oblong inclining to conical; yellow with red blush; crisp, tender, juicy, with pleasant sub-acid flavor; quality good. September and October.

Paw Paw.—A medium-sized apple of good quality and apparently a long keeper; yellow overlaid and striped with light red; roundish, oblong; firm, juicy, sub-acid. November to May.

Pewaukee.—Of large size and attractive appearance; yellow, striped, splashed and shaded with light and dark red and covered with light bloom; quality fair; firm, fine grained, dry; flavor mild. A promising market variety. December to March.

Rainbow.—Of medium size; roundish-conical; yellow overlaid with light and dark red; flavor mild, indistinct; rather dry, fine grained; quality low. Last of August.

Reynard.—A very large yellow apple of fair quality; form oblong; flavor mild sub-acid; texture coarse, breaking, rather dry. Season October and November.

Sabadkai.—Medium to large size; yellow with faint tinge of red at the base; oblate; tender, crisp, fine grained with mild sub-acid flavor.

Scotts (Winter).—Size medium, oblate; color yellow overlaid with stripes and splashes of light and dark red; firm, crisp, juicy, with brisk sub-acid flavor; quality good.

Summer Red.—Of medium size, roundish-oblate; color yellow overlaid with dark reddish-brown cheek; flavor mild almost sweet; texture firm; quality fair. Season September.

Thompson (10).—A medium-sized apple of fine appearance; roundish to oblate; yellow with light and dark red splashes and stripes; firm, moderately juicy; flavor sub-acid; quality good. Season September.

Thompson (38).—Large, roundish-oblate; greenish-yellow, striped and splashed with red; firm, crisp, juicy; quality fair. Ripe last of August. Promises to be productive and may be valuable for home use or market.

White.—A very large white apple of attractive appearance, but of low quality; tender, dry, mealy, sub-acid. Season last of August.

Yellow Bellflower.—An old well-known variety once quite largely planted, but being replaced by other varieties at present. Of medium size, oblong, irregular; color yellow with occasionally a bright red cheek; tender, juicy, crisp, with high sub-acid flavor. A good keeper, and excellent for culinary and dessert purposes, but comes into bearing late. Season December to March.

NOTES ON OLDER VARIETIES.

Antonovka.—A very large yellow apple of Russian origin. Oblate conical, with brisk sub-acid flavor; as yet unproductive. Season last of August and early September.

Arnold.—Large, yellowish-white, of good quality. Too light in color and tender in texture to prove valuable for market, but an excellent variety for home use. Trees thrifty and productive. Season November to March.

Bailey.—A very large, showy, red winter apple of sweet, pleasant flavor. Trees fairly vigorous and productive. One of the best sweet varieties.

Battullen.—Fruit below medium in size, but smooth and attractive; quality good. Tree vigorous, but as yet has not proved to be productive.

Ben Davis.—An old well-known variety that has been largely planted, but is being replaced by other varieties in Michigan, on account of poor quality. A long-keeper. Trees hardy, vigorous and productive.

Bietzheimer.—One of the most attractive apples in appearance, but of low quality. Trees fairly vigorous but unproductive.

Borovinka.—Of Russian origin. Trees hardy, vigorous and productive. Resembles Oldenburg in both tree and fruit. Season last of August. A valuable market variety.

Bottle Greening. Tree vigorous, fairly productive. Fruit large and of good quality; rather tender for market, but a fine dessert fruit. Season November to February.

Buckingham.—Of large size; color greenish yellow, shaded with light and dark red; quality fair. November to March.

Canada Baldwin.—Size medium; color yellow, striped and splashed with rich light and dark red; quality good. Tree vigorous, but has proven to be unproductive so far. Season December to April.

Carlough.—Above medium in size and of good quality, but too light in color to make a good market variety. If productive, will be valuable for home use as a long keeper. Season December to April.

Chenango.—Tree vigorous and productive. Fruit of large size, oblong conical; color yellow, striped and splashed with red; quality best. Valuable for home use and near-by markets. Season last of August.

Colton.—An early and abundant bearer. Size medium; color greenish-yellow. Valuable for home use as an early-ripening variety. Last of July.

Cornell.—Of medium size; color yellow, shaded and striped with light red; tender, fine-grained, with mild sub-acid flavor; quality good. Tree lacks vigor and productiveness as yet. Ripe early September.

Cullin.—Size medium to large, of good quality and a long keeper. Rather too light in color for a good market sort. Tree not vigorous, but fairly productive.

Duchess Seedling.—Large, smooth, attractive, of fair quality. Somewhat resembles Oldenburg in tree and fruit; ripens a few days earlier. Promising.

Early Joe.—Below medium in size; of excellent quality. Good for home use. Late August and September.

Fameuse.—An old, well-known variety, and at one time very popular. Of the finest quality, and valuable for the garden collection. Ripened fruit for the first this season, on twelve-year-old trees.

Fanny.—Of medium size and attractive appearance; color dark, rich red; quality best. Promising for both home and market.

Flushing (Spitzenburg).—A medium-sized dark, rich red winter apple, of good quality. Tree fairly vigorous, but late in coming into bearing. Season November to March.

Garden Royal.—Of the finest quality, but valuable for home planting only.

Gideon.—Tree hardy, vigorous and very productive; size medium to large; color yellow, with pale red cheek; very handsome; flavor brisk sub-acid. Valuable for home use, or market where an early fall apple is desirable.

Grimes (Golden).—Tree vigorous and productive. Fruit smooth, medium-sized, yellow, of excellent quality. Valuable for home use or market.

Haas.—Size medium to large; color yellow, red-striped; quality fair to good. Has no distinctive qualities to make it valuable here. Season October and November.

Hagenkopt.—Large, roundish, conical; color yellow, striped with light red; quality low. Not valuable. September.

Hubbardston.—Of large size and attractive appearance; quality very good. Tree fairly vigorous and an abundant bearer. Valuable for home or market. Season November to February.

Iowa Keeper.—A firm-fleshed, long-keeping variety; below medium in size; quality fair. Too small to be of value as a market sort. Trees vigorous and productive. Season December to June.

Jefferis.—Tree fairly vigorous, very productive. Fruit small to medium; color yellow, striped with dark, rich red; quality best. Valuable for home use. September.

Jersey Sweet.—A very prolific early sweet apple; quality good; color yellow, striped with red.

Jonathan.—One of the most popular apples known for home use and market. Has been and is at present largely planted for commercial purposes. Size small to medium; color yellow, shaded with mottled dark, rich red; quality very best. Season November to March.

Keswick.—One of the hardiest and most productive varieties grown. Valuable for home use as an early-ripening sort for culinary purposes. Ripens over long season.

Kinnaird.—A dark red winter apple of attractive appearance, large size and good quality. Tree vigorous in growth but as yet not very productive. Requires further trial.

Limber Twig.—Of small size and of only fair quality. Not promising.

Longfield.—Tree fairly vigorous and very prolific. Size medium; quality good. Season September and October.

Louise.—A seedling of Snow, but not so attractive in appearance as that variety; flavor and quality much the same, but the trees come into bearing much earlier than that variety. November to January.

Lowell.—An old, well-known variety commonly known as Greasy

Pippin. Tree vigorous and very productive. Fruit of large size and good quality. Valuable for home use.

Magog.—An attractive yellow, striped apple of fair to good quality. Slow to bear. Not promising.

Mason (Orange).—Size medium to large; yellow, with red cheek; of excellent quality. Rather tender for market but valuable for home use. Season November to February.

McIntosh.—A medium-sized, dark red apple of good quality. Tree vigorous and productive. October to January.

Milwaukee.—Size large, roundish-oblate; color yellow, striped red; texture crisp, tender, with brisk acid flavor. Tree vigorous and promises to be productive. Ripe middle of September.

Minkler.—An apple that can be safely recommended for commercial planting. Medium size; color greenish-yellow, overlaid and striped with red; of good quality; firm fleshed, and a long keeper. Tree vigorous and productive. January to April.

Morris Red.—Of large size, attractive appearance and excellent quality. Valuable if it proves productive. November to March.

Munson.—Size small to medium; of rich yellow color; smooth, with sweet, pleasant flavor. A good dessert apple. September.

Oakland.—A medium-sized, dark red, winter apple of good quality. Quite largely planted for commercial purposes. Tree a slow, spreading grower, moderately productive. November to March.

Oldenburg (Duchess).—The most popular variety for late summer and early fall market. This season it brought the highest price of any apple in station collection. It needs no recommendation.

Ontario.—A cross between Northern Spy and Wagener, and one of the most promising of the newer winter varieties. It combines the early

and abundant bearing qualities of Wagener with the large size and vigorous growth of the Spy. Of good quality and attractive appearance. Valuable.

Peter.—A seedling of Wealthy and practically identical with that variety. September and October.

Ramsdell.—A showy, red, sweet apple of fair quality. November to February.

Red Canada.—An old, well-known variety, once largely planted for market, but is now being replaced by other varieties. Fruit large, dark red, of fine quality; attractive in appearance and a long keeper. November to April. Trees lack vigor and are late in coming into bearing.

Red June.—A medium-sized, dark red apple, attractive in appearance and of very good quality. A popular early market sort as grown South for Northern markets. Tree vigorous and very productive.

Ronk.—Size medium to large; color yellow, clouded with dull red; quality good. Tree upright, spreading, rather slow in coming into bearing.

Rosenhager.—A Russian apple of large size; brownish red in color, but of poor quality. Tree vigorous and productive. October to December.

Roxbury (Russet).—Of large size and very good quality. Considered valuable for home and market. Season December to June. Tree vigorous, but late in coming into bearing.

Scarlet Cranberry.—Of medium size, fair quality. Tree vigorous, moderately productive. December to April.

Shannon.—A large, smooth apple of greenish-yellow color; quality good. One of the newer varieties that may prove valuable. December to March.

Sheriff.—Small to medium in size; color bright red when fully matured; texture crisp, tender, juicy, with mild sub-acid flavor; quality very good. Tree moderately vigorous, very productive. November to March.

Shiawassee (Beauty).—Similar to Snow in flavor and quality, but is larger and superior to that variety. October to January.

Stark.—Of large size; color yellow, shaded and striped with dull red; quality good. Tree vigorous and very productive. A valuable variety for home or market. December to May.

St. Lawrence.—A large, red-striped, attractive fall apple; quality good. Planted to some extent for market, but not so desirable as other varieties ripening at that season. September and October.

Stuart.—Of small size; color yellow, with red cheek; quality good. Not desirable.

Summer Lievland.—Of medium size; yellow, striped red; of fair quality. Not desirable.

Summer Rose.—A handsome dessert apple, ripening in August; color greenish-white, shaded with bright red. Valuable for home planting.

Thompson (29).—A large, greenish-yellow apple of fair quality. Will require further trial.

Titovka.—Of Russian origin, and one of the most productive varieties on station grounds. Fruit large and handsomely colored; ripens a few days before Oldenburg. Tree a poor grower. Valuable for home or market.

Walker.—Medium to large; greenish-yellow, splashed and washed with red; firm-fleshed and a long keeper. December to April.

Washington Strawberry.—Of large size and good quality; color yellow, striped and splashed with red. Tree fairly vigorous and productive. Of value as a market sort. September.

Wealthy.—Tree moderately vigorous and an early and abundant bearer. Fruit large and handsomely colored. A valuable fall market variety. Follows closely after Oldenburg, and is a valuable sort to plant with that variety.

Whinery.—Is a comparatively new variety that as yet has proved unproductive. The fruit is of medium size, attractive in appearance and a long keeper. December to April.

Yellow Transparent.—Of Russian origin, and one of the most valuable varieties grown for home use and nearby markets. Of medium size; pale yellow in color; tender, juicy, sub-acid. Last of July and early August.

CRAB-APPLES.

NOTES ON VARIETIES.

The following points were noted in regard to harvesting and marketing crab-apples. In harvesting, the fruit must be picked while firm and crisp. If an attempt is made to hold the fruit over, it invariably gets dry and mealy and the market quotes all such down. There is very little demand in the city markets for varieties that ripen in August, except Whitney and others that are used largely for dessert purposes. The demand begins at the end of the first week of September and continues until well into October. Hyslop was quoted at the top of the market the whole season through.

August.—Size very large for a crab-apple; color yellow, washed and striped with red; crisp, tender; quality fair. August. Not considered valuable.

Dartmouth.—Of medium size; dark, rich red; quality very good; resembles Hyslop somewhat, but is not equal to that variety.

Florence.—The tree is an upright, spreading grower, moderately vigorous and very productive. Fruit small, inclined to overbear; color clear yellow, striped with light red; quality good. Late August and early September.

Excelsior.—Size large; handsomely colored; of good quality and very productive. Rather tender, but excellent for home use or near-by markets.

Gibb.—Of medium size; pale yellow; poor in quality. Not valuable.

Jelly.—Tree vigorous, but as yet only moderately productive; color yellow, overlaid with bright red; size small; quality good. Considered of some value for culinary purposes.

Martha.—A medium-sized, handsomely colored apple of excellent quality; gave the most satisfactory results of any variety on trial this season. Valuable. Early September.

North Star.—Inclined to run small; of only fair quality, and not attractive enough in appearance to be valuable.

No. 1 New.—Said to be a crab seedling, but classed with apples on the market. Very large, of attractive appearance and excellent quality for culinary purposes. Very tender and requires careful handling.

No. 2 New.—Like No. 1 New, this variety resembles the apple rather than the crab. Tree not so vigorous but more productive. Of smaller size and not so attractive in appearance. Not desirable.

Quaker.—A late-ripening variety of only fair quality. Size medium to large; color yellow, with red cheek. Tree handsome, vigorous, but not very productive. October.

Whitney.—Medium to large; color yellow, shaded with light and dark red, and has a sprightly sub-acid flavor; quality very good. Used to some extent for dessert purposes. Tree vigorous and productive. Valuable.

QUINCES.

NOTES ON VARIETIES.

Alaska.—Smaller than Orange, but otherwise not very different from that variety.

Orange.—Medium to large; greenish-yellow; firm, crisp, of good quality. An early and an abundant bearer.

Meech.—Below medium in size; slightly pear-shaped; greenish-yellow. Season very late.

Missouri.—Of largest size and best quality, but only moderately productive. One of the earliest to ripen.

Rea (Mam).—The most profitable variety in the list. Very large, vigorous and productive. A seedling of the Orange, but larger and finer quinces than that variety.

Van Deman.—Medium to large. Seems to differ little from Orange.

NUTS.

Four varieties of chestnuts fruited this season. Cosford and Kentish Cob filberts bore a partial crop and the Japan walnut trees again bore a full crop. The English walnut is apparently of no value here, lacking in vigor and hardiness. A number of varieties that had been grafted on different stocks were received this spring from the Division of Pomology. In this way we may be able to get some variety that will be vigorous and hardy enough to be of some value in this climate.

CHESTNUTS.

EUROPEAN VARIETIES.

Comfort.—Tree a strong, vigorous grower. Nuts of large size; rich dark brown color, and excellent quality, but as yet lacks productiveness.

Numbo.—Tree a poor, slow grower here; moderately productive. Nuts medium to large size; quality good. Not valuable here.

Paragon.—This variety is by far the best variety on trial. Tree vigorous and an early and abundant bearer. Nuts of large size and excellent quality. Worthy of a place on every farm and home grounds where

the climate is suitable. In the eastern part of Michigan the native chestnut grows on deep, sandy, gravelly soils and usually on ridges.

JAPAN VARIETIES.

The trees of this group are dwarfish in habit and slow growers. Nuts are from medium to large in size, but are inferior in quality to the European varieties and are borne in much thinner burrs. Of the five varieties of this group on trial, Hale, Superb, Japan Giant, Japan Improved and Reliance, the last named was the only one which fruited this season. It promises to be the most productive variety of this group. Bore a full crop this season from tree planted in 1899. Tree a slow grower but this may be due somewhat to its productiveness. The nuts are of medium size, good quality and borne in very thin burrs.

FILBERTS.

Cosford (Thin Shell).—A thin-shelled variety of fine quality. Hardy and quite productive. Valuable for home use and ornamental purposes.

Kentish Cob.—This variety is more vigorous than Cosford, but as yet not quite so reliable. The nuts are much larger and of good quality.

WALNUTS.

Japan Walnuts (*Juglans Seiboldii*).—Trees hardy, vigorous and productive. The nuts are borne in large clusters and are a little smaller in size than the English walnut, which they resemble in shape. Quality fair and in flavor something like our native butternut.

COVER CROP EXPERIMENT.

Eleven plots (of a quarter of an acre each) were sown with different kinds of cover crops—cow peas, broadcast; cow peas in drills twenty inches apart; sand vetch; Canada peas; Crimson clover; Mammoth clover, oats, buckwheat, rape and flat turnips, broadcast. One end of all but one of the plots was sown to oats with the original sowing, barley being used on this plot in the place of oats. The plots were sown the 10th of August. At the beginning of winter the following points were noted: As a cover crop, the cow pea is almost a failure except where the oats were sown with it. It made a fine growth and was no doubt valuable in adding nitrogen to the soil. Drilling is to be preferred to broadcasting in this case. As a cover crop, oats seem to be ideal this season, with barley, buckwheat and sand vetch following closely, and on all the plots where oats were used with them their value as a cover crop was improved. No difference is noticeable at this time between Crimson and Mammoth clover. While the clover has not made as good a showing as a cover crop as some of the other plants, observations in the spring at the time of plowing may show it to be of more value. It is conceded by all that clover is the most valuable crop that can be sown in the orchard, where the conditions are favorable for it, as it is much more reliable on sandy soils than on clay.

T. A. FARRAND.

South Haven, January 7, 1903.

NOTES ON SMALL FRUITS.

BY M. L. DEAN.

STRAWBERRIES.

The season of 1902 was unfavorable for the growing of strawberries of the best quality. Late frosts in some localities ruined the earlier berries and more or less impaired the quality of the general crop. The extremely wet weather retarded the development of pollen and many blossoms were not properly fertilized, causing many green-tipped, poorly formed, knotty berries. There was a tendency, however, for the berries to be of extra size, but they were rather soft and lacked in flavor. This in a measure affected the scoring of the varieties and improved the rating of some, while others rated low in color, texture and flavor. The varieties having imperfect blossoms showed the most serious lack in fertilization.

NOTES ON THE NEWER VARIETIES.

Auto.—Received from Slaymaker & Son, Dover, Del. The flowers are perfect. The vines are very vigorous and hardy; foliage small but dense. There seems to be a tendency to throw an excess of runners, and they should be kept well pruned to encourage fruit development. The plants are very productive and developed a large percentage of imperfect, irregular berries. Late frosts and cold, wet weather might have caused much of this trouble. The berries are uniformly large, round, conical, bright crimson; flesh pink, pleasant and desirable in quality. For vigor and productiveness the variety seems to be of much promise. The uniformity of berries through the season is a striking peculiarity. The berries ripened two days later than Haverland.

Belle of La Crosse.—Received from John A. Salzer, La Crosse, Wis. Flowers perfect; foliage medium size, dense, dark, glossy green; fruit stems are very numerous, stout and upright. The berries are of medium size, broad, round conic, regular, bright crimson, and thickly covered with seed, which makes them very attractive. The pulp is firm, reddish, rather acid, but pleasing.

A very productive sort and promises to be of some value as an early market variety.

Cameron's Early.—Received from D. Brandt, Bremen, Ohio. Flowers perfect. The vines are extremely strong growers, and have long, stout, upright leaf stems; leaves large, coarse, dense, light green, and show a tendency to rust.

The fruit was lacking, in proportion to the growth of vines. Frost hurt them badly, so it is hard to judge as to productiveness without further trial. They blossom full, but the fruit stems are lacking in berries. They are stout and upright; berries usually round, regular, conic, some slightly elongated and a little irregular; color, bright crimson; tex-

ture, firm; flavor, rather acid. Its extreme earliness makes it very promising for an extra-early variety.

Commander, from the same grower, has perfect blossoms.

The vines seem to lack in hardiness, but are vigorous, strong growers; foliage large, broad, dark green. The runners are not numerous, but sufficient for the growth of the plants; fruit stalks short, stout, few but well filled; berries are of good size, a little irregular, round, broad conic; seeds are deeply set, numerous. The pulp is firm, dark crimson, reddish clear through; flavor pleasant acid. An attractive berry of promise for fancy purposes. Season medium.

Corsican.—Received from Green's Nursery Co., Rochester, N. Y. Flowers perfect. The vines are very vigorous, but seem to lack in hardiness. The foliage is large, broad, dense and of a dark, glossy green; runners scattering; fruit stems numerous, but they are not well filled. The berries were very large, round conical, and of a dark crimson color; flavor very pleasant; texture a little soft for market purposes. If, on further trial, the variety develops more fruit, the quality and appearance will make it a very desirable, fancy, medium early berry.

Crines Double Cropper.—Received from John Lewis Childs, Floral Park, New York. Flowers perfect. The vines are very hardy, vigorous and over productive. The foliage is small and has short, low-growing stems; runners superfluous; fruit stems numerous and over-loaded with small, dark scarlet berries. The shape of the fruit is regular conic, slightly flattened at the tip; pulp, pink, juicy but rather acid. The variety has the same tendency of over-productiveness as the Parker Earle and would be a good variety for hill culture when it can be given extra care and fertilizers. The season is medium.

Double Cropper from Brandt has perfect blossoms. The vines in vigor and hardiness are all that is desired. The foliage is large, dense, dark green; leaf stems long and stout; runners numerous. There seems to be an abundance of fruit stalks and they are well filled; berries are dark, bright scarlet, thickly seeded on the surface; form elongated conic; pulp firm, with a sharp, acid flavor. It has not developed any habits that the name would signify, but it is a hardy productive variety of some promise. Seems to be identical with Crines Double Cropper, from Childs. There was only one day difference in the season.

Duffs.—Received from J. G. Harrison and Sons, Berlin, Md. Flowers imperfect. In hardiness and vigor, this variety stands well. The foliage is dark green, large, and has stout, low-growing stems; runners numerous; fruit stems abundant and well loaded with small, conic, firm, bright scarlet berries of acid flavor. This variety came from North Carolina and is inferior in quality to many other early sorts.

Everbearer.—Received from Jno. A. Salzer, La Crosse, Wis. Flowers perfect. The plants are hardy, but lack vigor. The foliage is small, sparse and spindling; runners not numerous; fruit stems abundant, and well filled, but the berries are small; color, dark scarlet, round regular conic and thickly seeded. The flavor is pleasant and further trial may show improvements in some weak points. Season early to late.

Giant (Wisconsin).—Received from John A. Salzer, La Crosse, Wis. Flowers perfect. This is a very promising, medium variety, for large fancy berries. The vines are hardy and vigorous; foliage healthy, medium size, dense and of a dark, glossy green color. The runners are numerous but not over abundant; fruit stems of good number and well

filled. The berries are large, bright red, broad, regular, round conical in shape; pulp is light colored and firm for so large berries; flavor, pleasant, sharp and sprightly.

Hawaii.—Received from Flansburg and Peirson, Leslie, Mich. Flowers perfect; vines very vigorous and perfectly hardy; foliage of medium size, dense, bright green in color; runners numerous. The fruit stems are lacking in number, and are long, slender and fairly well filled with bright scarlet, elongated, slightly necked, rather irregular round berries. The pulp is a little soft, bright pink. The parentage is Haverland fertilized with Parker Earle and the combination should produce a valuable berry. Medium early.

Hero, from the above parties, has a perfect blossom. The plants are hardy but are not as strong growers as some varieties. The leaves are broad and thick; stems stout, stiff and have red markings, some being entirely red; runners are about medium in number. The fruit stems were not numerous and they lack in quantity of fruit, but the frost was partially the cause. The berries are medium to large, broad, conical, regular, bright red, thickly seeded and have a pink pulp of good texture and pleasant flavor. If they prove to be more productive they will be a valuable variety for fancy fruit of high quality, for early trade.

Howard No. 2.—Received from G. W. Howard, Stevensville, Mich. Flowers imperfect. The plants seem to be very strong growers, but winter-killed some. The leaves are large, dense and dark green; runners few; fruit stalks scattering; berries large, round, regular conic, bright crimson, juicy, a little soft. The flavor is mild and pleasant, but not especially striking. The fruit is very attractive, but unless the plants prove to be better bearers they will be of no value for general purposes. Season medium.

Jersey Market.—Received from J. G. Harrison and Sons, Berlin, Md. Flowers imperfect. Very hardy and of good vigor. The foliage is coarse and has large, tall stems; runners are numerous. The fruit stalks are numerous and well filled with medium to large, dark crimson berries, the pulp of which is firm, juicy, and has a delightful flavor. Owing to its productiveness, size, quality and strength of plants, it seems to be a promising medium late variety.

Late Mastodon.—Received from Jno. A. Salzer, La Crosse, Wis. Flowers imperfect. The berries which ripened were very attractive, medium to large, bright crimson, regular, round conic and have a very sharp pleasant flavor. The vines are hardy, vigorous and healthy, and have a dull dark green color. They made a remarkable growth of runners and fruit stems, but many of the blossoms failed to develop fruit, either from the effect of frost, wet weather or weakness of pollen. Season late.

Leo and Marie are two varieties received from Flansburg and Peirson. The vines of Leo are rank growers, hardy and have large, broad, rather light colored foliage, but showed a tendency to blight. The runners were numerous; fruit stems large but lacked berries. The berries were light colored, coarse and rather irregular; flavor mild and sweet; pulp soft. Further trial may develop more favorable points. Flowers perfect. Season medium to late.

Marie has imperfect flowers, and is a very attractive, desirable mid-season sort. It seems to lack a little in hardiness but is quite vigorous. The vines have small, dense, dark-colored foliage and but few runners; fruit stems are not very numerous, slender, but well loaded. The berries

are round, uniform, regular conic, dark crimson and thickly covered with bright golden seed; pulp firm, crimson and of excellent flavor.

Manokin.—From Slaymaker & Son. A medium to large, attractive berry. The plants seem to be vigorous and productive, throwing a preponderance of runners and stems; but the stems are long and well loaded. The berries are regular in form, conic, bright crimson, firm, juicy and have a pleasant sparkling acid flavor, and range from medium to large in size. The flowers are imperfect. The fruit ripened about a week later than Haverland.

Monitor.—Received from R. M. Kellogg, Three Rivers, Mich. Perfect flowers. The vines are satisfactory in vigor and hardiness, and have small, dense, light-green foliage. The berries are of a bright scarlet color; large, broad, round, little conic; pulp deep red, firm and has a sharp pleasant flavor. The fruit stems are numerous and heavily loaded, while the runners are sufficient to make it a good variety for propagating. It seems to have many promising characteristics for a late variety.

Perfection.—From Salzer. A hardy, vigorous grower but it lacks in productiveness. The runners are scattering and the berries are small, conical, uniform and regular. The flavor is a decided acid. In color and appearance they are attractive, being firm and of dark crimson color to the core; flowers perfect. Of no special promise. Medium to late.

Ponderosa.—Another variety from Salzer. Has perfect flowers. It is a strong grower, but lacks in hardiness. The foliage is tall, dense, medium sized and has a dark, dull green, healthy color. It has an abundance of fruit stems and runners. The berries are medium to dark crimson in color, glossy, juicy and have an excellent flavor. The productiveness and quality makes it very promising as an early variety.

Porto Rico.—An imperfect flowered variety received from Flansburg & Peirson. It is very hardy and vigorous, and throws a large number of runners. The foliage is small, dense, low-growing and of a light green color; fruit-stems short, stout and well filled. The berries are elongated, somewhat flattened, dark crimson, thickly seeded, and lacking in flavor. The pulp is red and rather soft. It is supposed to be a cross between Haverland and Parker Earle. The habit is similar to Parker Earle, but it is not as productive. Season medium to late.

Rip Snorter.—Received from W. Rapp, Terre Haute, Ind. Has perfect flowers, dense, dark green, glossy foliage, which usually indicates plants of strong vigor. The fruit stems are numerous and well filled, but many of the blossoms were blasted, showing that they were susceptible to injury from frost. The berries that matured were large, round, broad, light-colored and of good flavor, but a little soft. If all the blossoms set and the berries matured it would be a very productive variety but they seem to be easily killed by frost. The season was medium to late.

Simons Early.—Flowers perfect. Received from Slaymaker & Son. The plants lack in hardiness, but seem to be of good vigor. The runners and fruit stems are numerous. The berries are attractive and of good flavor but the pulp is a little soft for an early market berry.

Table Queen.—Received from D. Brandt, Bremen, Ohio. Has perfect flowers. The plants appear to be weak, spindling growers and throw too many runners and fruit stems. The berries are small to medium in size, nearly round, light colored, and have a rather insipid flavor. Further trial may develop more favorable characteristics. The season is medium.

Uncle Jim.—Also called Dornan, after J. F. Dornan of Glenn, Mich., the originator. The flowers are perfect. The plants are vigorous, but they winter-killed slightly. The foliage is dense, of a dark, glossy green, healthy color. The berries are somewhat elongated, almost necked, large, bright scarlet. They have a firm pulp and pleasant flavor, but lack a little in juice. The runners and fruit stems are numerous, showing productiveness in both plant and fruit. Season medium.

Uncle Sam.—Received from D. Brandt, Bremen, Ohio. Has a perfect blossom. The berries ripen about the same season as the Bubach. The vines are thrifty and hardy, productive of plants and fruit. The berries are broad, medium to large, round, a little flattened, light colored, have a pleasant flavor, but the pulp is a little soft. The season was one day later than Uncle Jim. It is a seedling originated in Ohio and owing to vigor of plants and productiveness it warrants further trial.

11-59 P. M.—Was sent out by the Hale Nursery Co., South Glastonbury, Conn., and was afterward named Midnight by Mr. Hale. The flowers are perfect. The plants seemed vigorous but lacked in hardiness, many being winter-killed. In fruit stems and berries it ranks high, but it appeared to be a poor plant grower, the runners being scarce. The berries are large, rough, necked, light colored and of medium quality. It is a very late variety, and it may prove to be of some value by further trial on that account.

VARIETIES REPORTED ON LAST YEAR.

Bennett.—As reported, last year, the plants lack in productiveness. The berries are small but of good flavor for an early sort.

Bobolink did not develop any traits that warrant giving the variety further trial. It might have a place among strictly fancy berries where extra care could be given. Season, early-medium.

Bryan lacks in hardiness and productiveness. Season, medium.

Bush Cluster has a strong growing plant and is a good pollenizer, but the berries are too light colored to rank among the popular mid-season varieties.

Carmi Beauty is an early to medium berry of promise. The quality is good and in productiveness and vigor of plant it has few superiors.

Carrie Silvers failed to develop any promising characteristics. The berries are of good quality, but the plants are poor growers. Medium.

Crockett.—The berries are not up to the standard in quality. It is a great plant grower but not promising for fruit of the best flavor. Mid-season.

Dole holds up in quality very nicely. The fruits are attractive and of good quality for early berries.

Downing's Bride is a promising mid-season variety. Color of berries, dark crimson; quality, excellent. The plants are vigorous and strong growers. This was also placed on the market under the name of Kittle Rice.

Dunlap proved to be low in productiveness and the berries were too rough to warrant special recommendation. Medium to late.

Empress and Emperor seem to be good berries for late fruiting. Under special care they are of good size, very attractive and of fine quality.

George's Triumph.—The berries are too small and rough to be attractive for the market, although it is a very productive, medium late sort.

Gibson resembles Marshall in fruit, but lacks in growth of plants. It ripened five days later than Marshall.

Gladstone improved as the plants reached two years growth and it would have a place among the extra early desirable varieties, if the berries were smoother and darker colored.

Joe is not particularly promising. Season medium to late.

Kansas.—The berries are too small to warrant general culture, owing to there being so many other mid-season varieties of merit.

Klondike seems to hold up as an extra late variety. The fruit is dark colored, regular in shape and of medium quality. The plants are strong growers.

Lady Jane.—The berries are light colored and small.

Livingston seems to warrant a place among the canning varieties. It is productive and the berries are of good color. Mid-season.

McKinley has a large, attractive berry, and still holds its place as a desirable medium late berry although it was very soft this season.

Mexican should be given hill culture, as it is a strong feeder. The fruit is large and of excellent quality. Early to medium.

Mrs. McDowell did not prove to be as good as last season. The berries were very soft and of poor flavor, rough and irregular.

Nettie improved in productiveness, but the berries were too soft to be valuable for shipping. Season, medium to late.

New York did much better than in previous years, but is still far behind what is claimed for it by some growers. It is worthy of trial on good soil for an early medium variety.

Parson's Beauty.—The berries are somewhat irregular, which mars the attractiveness of an otherwise good, early medium berry. In growth of plant they are desirable. Nearly identical with Pocomoke.

Pennell.—The growth of plant is hardly sufficient to warrant its becoming a standard variety for the mid-season trade.

Pocomoke.—The berries were large and of good flavor, but many of them were fan-shaped. It is a very productive variety and of the Wilson type. Medium to late.

Reba seemed to be very tender and succumbed to the winter. Medium to late.

Repeater.—The berries were much larger than the first crop, but in a dry season the plants could not carry the crop to maturity. Season, early medium.

Robbie is too light in color to be popular for Michigan markets. Season, late.

Rough Rider claims a place among the desirable varieties. It is not a heavy bearer, but the fruit is of good quality, attractive, and maintains its size through the season. A late variety.

Seaford has some good points, but none that would place it above many other late varieties.

Seedling No. 1 is perhaps worthy of a name for a home berry. The berries are dark colored and have a pleasant flavor, but are a little soft. The season is about medium.

Shepherd did not seem to rank as well as in 1901. The berries are light colored and lacking in quality. Season, quite late.

Stella.—The berries were very rough and irregular. The season is very late.

Stone 130 develops some traits of merit. Medium to late.

Sunshine falls short of what it was advertised to be. The berries are irregular and rough. It ranks as a medium late variety.

Twilight throws too many fruit stems for the strength of the plant. It seems to be rather early.

Up-to-Date.—As reported last year, this variety has no special value. It is of the old Sharpless type but not equal to it in value. Early medium.

1901 was of too poor quality to warrant further trial. Its season is medium.

SUMMARY OF STANDARD VARIETIES.

Beder Wood is one of the most popular, medium-early berries grown. The berries are always large and of good quality. The plants are thrifty and productive, but somewhat subject to rust.

Brandywine.—The quality of the fruit, vigor and productiveness of plant makes this a standard among medium-late, fancy berries.

Bubach is a variety that is largely grown, because it will thrive under ordinary conditions. The berries are attractive in shape and color, of good size, and the plants are productive.

Excelsior and Michels Early are two extra early varieties. Excelsior is, in some respects, superior to Michels.

Gandy holds its place among the standard late sorts. While it lacks a little in quantity of berries, the size and quality meets the deficiency. It thrives on any good soil.

Haverland.—This is an all around general purpose berry that properly remunerates for any extra care given.

Marshall is a very attractive berry of high quality, but the plants seem to lack in vigor and are susceptible to rust unless sprayed with Bordeaux mixture.

Rough Rider, Parsons Beauty and several other sorts seem to be forging to the front for a place among the standard sorts. Many other varieties in the tests previously published in our bulletins have desirable features and with some growers are pronounced superior to the above, but space will not permit the description of all good varieties, hence only such are selected as are likely to give the best satisfaction with the largest number of growers for general purposes.

RASPBERRIES.

From the lack of a desirable location the experimental varieties have been reduced until the list includes only a few of the better sorts. In the spring of 1901 a new plantation was set which will be reported as they come to fruiting maturity.

BLACK VARIETIES.

Coloma produced a small amount of fruit for the first time. The canes are of fair growth. The berries are jet black, medium size, and of good quality. Further trial is necessary to determine its real value. It is a mid-season, thornless variety received from John Wenslick, Coloma, Michigan.

Cumberland is one of the most desirable varieties of recent introduction. It is very productive. The canes are strong, vigorous and healthy, and seem to be very hardy. The fruit is a bright black in color, of good size and has a sweet pleasant flavor. They average about eleven to the ounce in weight. The first fruit ripened July 2 and the last July 30, holding their size and quality well through the entire season.

Eureka is a desirable early sort. Ripened June 20. The canes are thrifty and healthy. In productiveness they rank well. The berries are medium to large, round, a little conic, pulpy and have a pleasant flavor. Averaged 16 to the ounce.

Gregg is the most popular black cap grown and adapts itself to almost any conditions. With good culture there are few superior. The canes are strong, productive, but not quite hardy; berries attractive and of choice quality. 12 to the ounce.

Kansas is a very productive variety largely grown for commercial purposes. The berries are of good quality and of medium size. Averaged 16 to the ounce. Ripened June 28 to July 26.

Lotta seems to be very susceptible to the rust and anthracnose. The berries are of good quality but the canes lack vigor.

Ohio.—The canes are rather weak and spindling in growth but bear heavily. The berries are rather small, bright black, round, pulpy and of pleasant flavor. The period of ripening was June 29 to July 20. Averaged 30 to the ounce.

Pride of Ohio.—It is not as productive as some of the other varieties, but the berries are of a solid black color, firm and desirable. The canes are hardy, strong growers. Fruiting period, July 6 to 24. Averaged 20 to the ounce.

Livingston produced medium sized berries of fair quality. The canes are strong growers and productive.

Palmer.—The berries average too small to be popular, ranking 29 to the ounce. The canes are spindling but seem healthy.

PURPLE.

Shaffer is the best known variety of this class. The canes are thrifty and productive. Berries loose and of medium quality.

Columbian is of better color, firmer, and the canes are less injured by anthracnose.

RED VARIETIES.

Eaton, received from Amos Garretson, Pendleton, Indiana. The canes are hardy, strong growers; fruit, dark red, oval, medium size and has a tendency to rattle some. The quality is not up to the Loudon or Cuthbert.

Harris.—The fruit is of poor quality, and the canes have a short, stocky habit. The berries are of medium size, bright red, coarse, and crumble badly. The flavor is flat and insipid.

Loudon ranks as one of the standard red varieties. The canes are usually thrifty, and productive of berries of choice quality. This and the Cuthbert are two of the best red varieties.

Ridgeway was received from M. H. Ridgeway, Wabash, Indiana. The canes are very strong and thrifty growers but the berries are few in number and small. The flavor and texture is good.

Gold, a yellow variety, was received from the same party. The canes are good growers and the berries are good for their class, but there is no

place on the market for them, the popular demand being for black or red berries:

Muskberry, a novelty sent out by John Lewis Childs of Floral Park, N. Y., fruited for the first time this year. The canes are extremely rank growers, reaching 8 to 10 feet in height. They spread very badly from the roots, and, like the strawberry-raspberry, are a decided nuisance in a garden. The fruit is of good size and attractive in appearance but the flavor is insipid and disagreeable. The bushes throw off a musky odor.

BLACKBERRIES.

The soil and location here is such that it is impossible to grow blackberries with any degree of success.

Rathbun, Mersereau, Hess and other improved varieties have been tried several times, but they winter-kill every year.

Early Harvest seems to thrive as well as any variety and is very productive, in years when the plants do not winter-kill. The berries are large, thick and have a very small core. The flavor is pleasant.

Snyder and Taylor are two standard varieties that usually produce fruit of good quality in any section where blackberries are grown. While hardy and productive, the fruit is rather small.

CURRENTS.

In 1897 and 1898 several of the newer varieties of currants were planted and have reached maturity from a fruiting standpoint.

Eclipse, received from H. S. Anderson, Elizabeth, N. J., has strong, vigorous healthy bushes. The stalks are upright, stout and thickly covered with large leaves. The fruit stems are long and well filled, containing 12-16 rather small dark red fruits which have a sprightly, heavy, rich juice. The berries are rather small for fancy use, but the quality is fine for jellies and they are very productive.

Empire, received from J. Lewis Childs, Floral Park, N. Y., seems to lack in hardiness, as the bushes winter-kill and do not recuperate readily. The berries are large, of a bright, dark or ruby red, but the stems are short and contain only a few berries. The berries are of good quality and attractive, but the plants are not productive enough to be profitable.

Filler, received from Jos. H. Black & Son, Hightstown, N. J. Originated in Ulster Co., N. Y. The bushes are very coarse, upright growers, with dark rank foliage. The clusters are of medium size, long, well filled with bright red currants. They are of good size, attractive and have a pleasant, rich flavor.

London Market, received from Alexander Hamilton, Bangor, Mich., is a promising variety for general cultivation. The berries are a little larger than those of Pomona, and have a bright, clear, red color. The juice is thick, heavy, and of a pleasant, sprightly flavor. The bushes are thrifty and vigorous but not quite as productive as Pomona.

Pomona, received from Albertson & Hobbs, Bridgeport, Ind. This has proved to be one of the best varieties of recent introduction. It is a vigorous, thrifty grower and exceedingly productive. The clusters are long, and are filled with medium-sized berries, of a mild, rich, pleasant

RECIPES.

Collecting.—In collecting morels and puff-balls, or any other fungi intended for eating, discard all specimens that are overmature or infested with larvae. Puff-balls should be perfectly white inside when broken open. Yellowish stains in the center or near the base are signs of approaching ripeness and although not necessarily poisonous in this condition they develop bitter or unpleasant flavors, unfitting them for use as food. If dirt and adhering soil be removed when the plants are being collected much trouble in washing them clean may be avoided.

Cooking.

A great many ways have been followed in the cooking of edible fungi; in brief they are adapted to almost any treatment given to the oyster. Thus they may be stewed, baked, fried, broiled and escalloped, and made into croquettes or pâtés. Certain kinds, however, are treated in ways better suited to retaining or bringing out their natural flavors.

The following recipes have been selected as being specially adapted to the morels and puff-balls:

Morels.

Fried.—Wash, drain, roll in flour, fry in butter or fat, serve hot.

Stuffed.—Select the freshest specimens, open the stems at the base, wash carefully and wipe, fill with veal stuffing, anchovy, or any other rich stuffing, close the ends, bake or dress between thin slices of bacon. Serve with a sauce.

Simple and dainty.—Split the morels lengthwise, wash, drain, fry lightly in butter about twenty minutes, season and serve on hot toast.

Puff-Balls.

To fry.—Remove the outer rind, slice, dip into beaten egg, then into bread crumbs, fry until lightly browned in butter or fat as for French toast. A batter of milk and egg may be used in which to dip the slices before frying. Serve on a hot plate.

To stew.—Cut into small pieces, boil for fifteen minutes in a little water, pour off the water, dust with a little flour, add a small quantity of milk or cream with butter, salt, pepper, and lastly a little chopped parsley, stew slowly for five minutes, serve. They may also be used in pâtés.

—McIlwane.

Salads.—These may be made from the puff-balls, either raw or stewed, by mingling with any of the usual salad materials. Use the ordinary salad dressing.



Figure 21. The Cup-shaped Puff-ball. The wind scoops out the dry spore-mass and leaves the

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- 2—Pests of house and ornamental plants.
- 4—Apple orchard spraying, when and how.
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- 9—Farm accounts.
- 10—Sugar beets.
- 13—A review of Prof. Bangs' work on contagious abortion.
- 14—Foul Brood.
- 15—Spraying Calendar (1902).
- 16—Aeration of Milk.
 - When and What to Spray.
 - Prevention of Potato Scab.
 - Elementary Science Bulletin, numbers 1 to 8.

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

HORTICULTURAL DEPARTMENT

VEGETABLES AND BUSH FRUITS

BY

L. R. TAFT AND M. L. DEAN

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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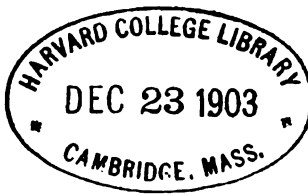
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Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.



Michigan State Library.

VEGETABLE AND BUSH FRUITS.

BY L. R. TAFT AND M. L. DEAN.

BEANS.

POLE VARIETIES.

Cluster Wax, from D. M. Ferry and Co., is a bean of superior quality. The pods are very tender and remain in edible condition much longer than most varieties. It is a valuable bean for its class and is very productive.

Golden Lazy Wife, from Wm. Henry Maule, is a very prolific variety. The pods are a bright golden color, very numerous and of good quality.

Nox All, from the same seedsman, is a green-podded sort and has some merit.

Royal Corn, from the Livingston Seed Co., is a productive bean of good quality. The pods are very tender.

Southern Prolific and **White Crease**, were both received from D. M. Ferry and Co. **White Crease** seems to be a selected strain of the **White Pea** bean and is a valuable variety as a dry shelled bean. **Southern Prolific** has tender pods and snaps readily but it is not superior to many of the standard sorts.

Worcester Pole, originated at Worcester, Mass., and is prized by market gardeners for its productiveness. Its quality is good and it has a long edible maturity. The beans are not clear white but are of good flavor as shelled beans.

BUSH BEANS.

This class includes a large number of varieties of good quality.

The **Valentine** type stands at the head for green pods and the **Wax** or **Butter** beans for yellow-podded sorts.

Brittle Wax, from Burpee, is a very productive green-podded variety. The pods snap readily and have a mild flavor.

Bountiful, from Henderson, is all that its name implies as to its productiveness. The pods are long, large, stringless and of a bright green color.

Coffee Berry, received from the Great Northern Seed Co., is a mere novelty, of no especial value. The kernels are small and light colored. The vines grow about two feet high.

Double Barreled Wax and First in the Market were received from D. Landreth and Son. First in the Market is a quick maturing green-podded sort of medium quality, but the edible period is very short. Double Barreled Wax is a selected strain of the wax type of good quality. The pods are broad and thick and do not become tough.

Giant Podded 'Stringless, from Maule, is a good green-podded sort. It is very productive and the pods are large, long and meaty. A good mid-season variety.

Jones Stringless, from D. M. Ferry and Co., has white seeds and is of excellent quality for an extra early variety.

Knickerbocker, Longfellow and Market Wax were all received from Peter Henderson and Co., New York. Knickerbocker and Longfellow are green-podded and of good quality. Market Wax is a good wax sort.

North Star, from Great Northern Seed Co., is a green-podded snap bean of good quality. The pods are long, tender and mature very early.

Pencil Podded Wax, Powell's Prolific and Quarter Century were received from Livingston Seed Co. The Pencil Pod is a wax bean of standard quality. Powell's Prolific is an abundant bearer, but the pods are a little tough. Quarter Century is a bush Lima but did not mature this season.

Sunshine Wax, from Bolgiano and Son, is a carefully selected strain of good quality. The pods are bright colored, tender and pleasant. It is a good, medium-early variety.

Trucker's Delight, from Holmes, is a Lima of considerable promise.

Levianthium, from Henderson and Co., is another choice Lima, but the weather was so wet that none of the Limas matured sufficiently to show their quality.

CABBAGES, 1902.

About the same varieties of cabbage, cauliflower, kale, kohlrabi, broccoli and Brussels sprouts were grown as in 1901. The season was such that many of the plants failed to head and a poor trial resulted. The broccoli developed some very fine heads equal to any of the cauliflower in quality.

The list of early varieties of cabbage included All Head, Early Jersey Wakefield, Etampes, Express, Henderson's Early Summer and White Giant from Vaughan Seed Co. Alpha from Currie Bros.; Base Ball, Flat Head, No. 78 and Stonehead from Burpee; Charleston and Early Drumhead from D. M. Ferry Seed Co.; Earliest from Gregory; Cracker Jack from Maule; Drumhead and Large Early Jersey Wakefield, from Dreer; Sure Crop from Mills.

There were several varieties that matured good heads early in the season. Base Ball and Cracker Jack were two varieties to develop the

earliest heads but they were very small. Etampes, followed by Early Jersey Wakefield and Henderson's Early Summer are varieties of good quality that can be relied upon.

White Giant produced some very large heads of extra fine quality. It was a little later than Henderson's Early Summer.

With the medium and late varieties better results were secured than in 1901.

Succession and Autumn King for medium, and Flat Dutch and Mammoth Rock Head for late, will generally prove satisfactory.

The American Drumhead Savoy gave some excellent heads of this type of cabbage and its culture should be encouraged. The quality is superior to the smooth leaved sorts.

The Brussels Sprouts were of better quality than in 1901. The small heads were solid, tender and of good flavor.

Some choice heads of cauliflower were grown of several varieties including the Erfurts and Snowball.

LETTUCE.

The test included the new varieties or novelties sent out by the different seedsmen, as well as most of the old kinds. The tests were made in the open ground.

All Heart, from Dreer, is a large, coarse-growing variety of the heading type. When given plenty of room in the row, the heads are large and attractive. The heart is tender and mild-flavored. It is of choice quality but, if crowded in the row, the heads are small and tough.

Continuity, Russia and No. 903 are three varieties from W. A. Burpee and Co. Continuity is a large, solid-headed sort having a tender, mild-flavored center. The outer leaves are thick, rather dark green and completely cover the heart. It is a good mid-season sort. Russia and No. 903 did not develop any traits of special value.

Crumpled Leaf, from R. and J. Farquhar and Co., is a large, heading sort. The foliage has a very dark green color and is coarse, requiring much room in the row. The heads are of good quality and mature early for so large a variety.

Crystal Head is a very quick maturing variety for so large a sort. The heads are of superior quality.

Density, Immensity, Precocity and Express were received from Peter Henderson and Co. Express is a medium-sized, close-growing lettuce of the Cos type. Precocity is a small, quick-maturing head variety. Density follows it in season, but is not as compact and has colored bordered leaves making it very attractive. Immensity has very large, coarse-growing heads, but they are compact and of good quality for such large heads. They make a good succession of head varieties.

Elliott's Leviathan, from Elliott and Sons, as last season, proved to be a valuable heading sort.

Rawson's Hot House was received from the same parties. It is a standard among the forcing varieties and is also a choice heading sort for garden culture.

Farmer's Pride, Golden Heart and White Loaf are three varieties received from J. Bolgiano and Son. They are all heading sorts and of good quality, making a good succession through the season in the order named.

Kaiser Wilhelm, Peer of All and Sunset were received from J. A. Salzer Seed Co. Kaiser Wilhelm is a very large heading sort. Peer of All is of medium size and very attractive, having a bronze red tint to the outer leaves. Sunset is small and dark green in color. The quality of all three is desirable.

Mammoth Black-Seeded Butter, from Livingston's Seed Co., is a standard for a large-growing, delicately blanched head lettuce. The rot bothered it some this season.

Pan American and Tender and True were sent out by F. B. Mills. Pan American is a heading sort. Tender and True is a loose, crinkled-leaved sort. They are both of good quality. Tender and True matures early but the seed stalk starts soon so that the edible period is very short.

Silver Anniversary from W. H. Maule, Sterling from Northrup, King and Co., Unrivald from J. A. Bruce and Co., and Unsurpassed from D. Landreth and Sons are all heading varieties of some merit.

Grand Rapids Forcing was the leading open-heading sort grown.

The head varieties were somewhat troubled with the rot this season, especially the larger sorts. The quality of the head varieties is superior to the open sorts but, in Michigan, the demand is for the Grand Rapids type in the garden, as well as for forcing.

NOTES ON PEAS.

Twenty-four varieties of peas were grown in 1902, including some of the common or standard varieties and some others that are types carefully selected from the older varieties and given new names.

Alaska, from D. M. Ferry and Co., is a standard early variety. It is very productive and matures evenly.

American Wonder, Hosford's Market Garden, Champion of England and Stratagem were all from the above seedsmen and are varieties of superior quality, following each other in season.

Athlete, from Rawson, showed a tendency to run to vines. The pods were scattering. It is a medium-late variety and the peas are of fine quality.

Blue Beauty, from Thorburn, is quite productive. The vines are about two feet high; pods three inches long by one-half inch wide and contain six plump, sweet, tender peas.

Bloomsdale, from Landreth and Sons, is quite tall and runs to vines. The pods are numerous and well-filled. Matures about the same season as Stratagem.

Dwarf Jumbo, from Salzer, was very slow to germinate. The vines are about eighteen inches high; pods few but large and filled with peas of the highest quality.

Dwarf Telephone, Rough Rider, Scorchers, Tom Thumb and Wife's Pin Money were all received from John A. Salzer. Dwarf Telephone made about one-half the growth of Champion of England but matured nearly at the same time. The peas are of superior quality. Rough Rider was of the Market Garden type, but lacked in productiveness.

Tom Thumb has a small low-growing habit. The vines are spindling; pods scattering and the peas are of only medium quality. Wife's Pin Money resembled Champion of England in growth and quality. The pods are numerous and the peas superior in quality. Scorchers is a quick-growing variety of great productiveness, but only medium in quality.

Giant Podded Sugar Pea, from Elliott and Sons, and Giant Podded, from Livingston, were nearly identical. They are both good varieties.

Giant's Favorite, from the Great Northern Seed Co., has been grown here several times. It seemed to be true to type, productive and of good quality. Matured at the same time as Champion of England.

Philadelphia Extra Early, from Thorburn, was one of the first to reach edible maturity. The vines are productive and the peas are of medium quality for so early a variety.

Perpetual and Prodigious, from Maule, are two tall-growing varieties of superior quality. Perpetual lacks in productiveness and has a long edible maturity, but Prodigious is very productive and the quality of the peas unexcelled. Medium to late in season.

Reliance, from Henderson, is a tall, rank grower, quite prolific. Pods well filled with choice peas. It is a medium to late variety.

Surprise, from Henderson, as previously stated is a productive, valuable variety for market garden purposes. It matures early and evenly.

Teddy Roosevelt, from Northrup, King and Co., is a very desirable, large-growing variety. The vines are vigorous and productive and the peas are of the choicest flavor. They are about the same in season as Champion of England.

SWEET CORN.

The thirty varieties of sweet corn included a few of the standard kinds and some of the leading new sorts.

The Mammoth Cory holds its place among the quick maturing sorts, although it is not strictly a sugar corn.

Champion and Early Evergreen are good varieties for second early.

Country Gentleman should be included in every collection, and Stowell or Mammoth usually lead for late varieties although some of the newer sorts that are selected strains from the older ones are of equally choice quality.

Baltimore, from Turner and Co., Baltimore, Md., matured in about eighty-five days. The stalks averaged about five feet in height; ears six inches in length and contained ten rows of kernels. The kernels were short and lacked in quality, but it is a quick growing variety.

Banana, from Farquhar, was about ten days later than Baltimore. The size and habit of growth were about the same but the quality was better, the kernels being sweeter and more tender.

Cosmopolitan, from W. A. Burpee and Co., is a good addition to the list of early varieties. It reached edible maturity a few days later than Baltimore. The ears are longer, averaged twelve rows and the kernels are broad, deep and of superior quality.

Don, from Weeber and Don, is of good quality for a medium-early variety.

Evergreen Early, from D. M. Ferry and Co., and Dobson's Evergreen Early, from J. C. Vaughan Seed Co., are nearly identical. The ears are long and well-filled with broad, deep, tender, sweet kernels. They averaged one ear per stalk. They are choice mid-season varieties. The ears averaged nearly a pound in weight.

First Crop, from Farquhar, and First of All, from Salzer, are small-growing varieties of the Cory type. The stalk and ears are small. First of All matured five days earlier than First Crop, which was edible in ninety days from planting.

Ford, from Ford Seed Co., is of the same type as First Crop and closely resembled it in every detail. Its early maturity is its most valuable trait.

Malakoff was received from the same source. It is a small, quick-maturing variety from Central Asia. The ears are small and short. Stalks only about three feet high. It reached edible maturity one of the first in the list, but the quality is poor.

Giant and Giant Improved are two varieties from W. H. Maule. Giant is classed as one of the desirable medium early varieties. The ears are good sized, symmetrical and well filled with choice kernels. Giant Improved is some later and the ears are larger but the quality is about the same.

Honey, from the Ford Seed Co., is quite a novelty. The stalks, leaves and many of the husks are dark red. The cob is usually red, but the kernels are a rich cream white, of good flavor. The ears are small. It matured in about 105 days.

La Crosse, from J. A. Salzer, is a medium early variety much like Mammoth Cory.

Market Early, from both Ferry and Vaughan, matured among the first varieties. They are identical in type and of medium quality.

Melrose, from Thorburn, is a variety of good quality. It has been previously described.

Metropolitan, from Henderson and Co., was about ten days later than Cory. The ears averaged about six inches in length and contained twelve rows of kernels of medium quality for an early sort. It is productive and a strong grower.

Neck, Red Cob and White Cob were received from J. Bolgiano and Son. Neck is a quick growing variety of medium quality. White Cob comes next in size and maturity, and Red Cob is a larger late sort of good quality. The latter has colored cobs. They are all of good quality.

Peep of Day, from Vaughan, is an extra early dwarf variety. It usually smuts badly and its only value is as an extra sort.

Perry's Hybrid, from Ferry, is a corn of excellent quality for a second early.

Premo, from both Bruce and Holmes, was identical. It is a medium early variety of some value but the ears are small.

Ringleader, from Rennie, reached edible maturity only five days behind the earliest sorts. It is an eight-rowed variety of medium quality for an early corn.

POTATOES.

One hundred twenty-five varieties of potatoes were grown in 1902, fifty of them being early and the balance late varieties. The seed was nearly all grown here. A few varieties being obtained from the following parties:

- Farmer Seed Co., Faribault, Minn. Arcadia and Lakeside Champion.
- F. B. Mills, Rose Hill, N. Y., Heavy Weight, Nameless and All Seasons.
- D. Landreth and Sons, Philadelphia, Pa., Prince Edward.
- Wm. Rennie, Toronto, Can., Rose of the North.
- Vaughan Seed Co., Chicago, Ill., Hewes.
- Wm. S. Huntington, Owosso, Michigan, A quantity of Seedlings.

From the sub-station at Chatham, in the Upper Peninsula, a quantity of potatoes were received, some of which had been pitted, a part kept

in an ordinary cellar and the remainder had been left in the field without digging. The ground was deeply covered with snow all winter, which prevented any injury to the tubers from frost. These lots were planted side by side, but there was no difference in germination or growth, showing that if the ground is thoroughly protected by snow, potatoes are not injured when left until spring. As a general practice, it would be hazardous except in the extreme north.

The season was so wet and cold that the late varieties made a rather poor showing. The potato blights were quite troublesome in some localities but by thorough spraying with Bordeaux mixture, the crop was very free from these diseases. The tubers were very free from scab, the seed having been treated with the corrosive sublimate treatment. The notes will only include some of the best of the newer varieties and those grown this season for the first time. The new varieties are as follows:

Arcadia is one of the most promising. It yielded 251.38 bushels per acre. The vines are upright, rank growers, tubers oval to roundish, flattened in shape. The color is a delicate pinkish white, eyes shallow, giving them a smooth surface. The quality is good. It matured among the earliest varieties.

Hewes yielded 290.26 bu. per acre. The vines were strong growers and the tubers are of good quality and are well bunched in the hill. It is of the Ohio type in season, growth and form.

Prince Edward, is of the Rose type and gave a yield of 155.49 bu. per acre. The tubers are of good quality and resemble the Early Rose in shape and color, but the vines are not as strong growers. They matured a little later than the Early Ohio.

Rose of the North gave the third heaviest yield (451.94 bu. per acre), among the early varieties. It is not a strictly early sort but ranked as a second early. The tubers are elongated, little flattened; eyes shallow, slightly pink in color. The vines are branching, thrifty growers and mature very evenly. The quality of the tubers is excellent and they appear to be good keepers.

Among the early varieties or those ripening with Early Ohio, are several promising sorts.

Coles is a very attractive and desirable early sort. It has been grown here three years and gives an average yield of 225.89 bu. per acre. In 1902 it yielded 300.62 bu. per acre.

Eureka received from Burpee in 1902, averages 272.06 bu., yielding 378.37 bu. in 1903. It has a clear white slightly netted skin.

Michigan still holds its place as one of the leading early white potatoes. In 1903 it yielded 372.19 bu. It has been grown here seven years and gives an average yield of 212.49 bushels per acre.

Minnehaha shows an average for five years of 229.6 bu. In 1902 it produced 360.22 bu., but the tubers were rather irregular in shape.

Norwood was received from Rawson in 1901 and is a choice variety. It yielded 217.69 bu. in 1901 and 279.89 bu. per acre in 1902.

Salzers Early is not a heavy yielder, but it is one of the quickest maturing red varieties in the list. The yield for 1901 was 161.88 bu.; in 1902, 181.14 bu. per acre.

Silver Crown stands among the leaders, both in quality and quantity. Sunlight is very similar. They are two very desirable early white varieties. Silver Crown gave the heavier yield (1901, 180.12 bu.; 1902, 378.38 bu.) while Sunlight gave 215.10 bu. in 1901 and 264.34 bu. in 1902, an average slightly in favor of Silver Crown.

Triumph averaged 284.72 bu. per acre for the past two years, yielding 395.81 bushels in 1902. It is a promising variety.

MEDIUM AND LATE SORTS.

All Seasons, is a mid-season variety, with a yield of 259.16 bu. per acre. The tubers resemble Early Rose, oval in form with pink markings and are of good quality. The tops are upright, with a spreading habit.

Heavy Weight, is of the Carman type. The tops are strong, upright growers. The tubers are well bunched in the hill, white, regular, oval, slightly flattened, very smooth and white. It is an attractive variety but no better than many others of the same class.

Lakeside Champion is said to have originated in the western part of Michigan. The yield (168.45 bu. per acre) was not large, but the tubers which are elongated, and of good size are of fine quality and fairly attractive.

Among the second early varieties, the new Early Carman is prominent. It ripened soon after the early sorts and yielded 388.74 bu. of very smooth, white potatoes.

Daughter of Rose was slightly later. The yield was very promising (456.13 bu.) but the tubers were uneven and rough, Rose colored.

Irish Cobbler (435.40 bu.) holds its place as a second early, ripening only about ten days later than Early Ohio.

Early Peachblow (263.97 bu.) was a few days later than Irish Cobbler and gives an average of 193.96 bu. per acre for seven years.

Pioneer matured nearly with Irish Cobbler and yielded 414.65 bu. The tubers are smooth and of the best quality. Very promising.

LATE VARIETIES.

Among the late varieties there are a large number that resemble Carman No. 3, and many appearing to be either selections or seedlings from that variety. The list includes Battles Best, Dewey, Free Silver, Free Trade,

Good Times, Mark Hanna, McKinley and Million Dollar, all of which are nearly identical in growth and yield.

Cannon Ball represents the large round, red class and is a heavy yielder.

California Russet is a true russet potato and in such wet seasons as 1902, seems to be more immune to the rots than the white varieties.

Enormous, Commercial and Hilers Choice are of a rougher type and have pink markings. The late varieties gave average yields ranging from 190 to 400 bu. per acre.

TOMATOES, 1902.

One hundred varieties of tomatoes were tested in 1902. About one hundred plants each of Beauty, Dominion Day, Ignotum, Lorillard and Trophy were grown to single stems and trained to stakes about four feet high with very good results. The fruit was larger, at least two weeks earlier and very free from the (*cladosporium fulvum*) rot which usually attacks the tomato in wet seasons. The staking method is one of the best ways to grow tomatoes of superior quality. The extra labor connected with this plan is in setting the stakes, pinching out all laterals and tying up the plants, which can be quickly done if attended to. Cultivating can be done much better and the plants can be set closer than when planted in the ordinary way.

Aristobright, Dandy Dwarf, Multi Colors and Royal Colors are novelties sent out by the Livingston Seed Co. last year as numbers 1, 2, 3, and 4. They are described in Bulletin No. 196 and are of no value. Many of the newer sorts are so nearly identical it is difficult to note any distinguishing characteristic.

Bolgiāno's Best, from J. Bolgiano and Son, Baltimore, Md., has vines of a rank, spreading habit. It is a medium early variety. Fruits bright red, firm and solid, but with a tendency to be slightly rough.

Acme, early, medium size, purple, rather rough. Very productive.

Advance, extra early, small to medium, bright red, very smooth. Good.

Atlantic Prize, early to mid-season, medium size, bright red, slightly rough.

Beauty, second early, medium to large, purple, smooth, very desirable.

Belmont, mid-season, medium to large, Trophy type, bright red, smooth.

Best of All, mid-season, large, bright red, nearly smooth, productive. Good.

Bird, early, small, dark red, smooth, very productive.

Brandywine, mid-season, medium to large, red, smooth.

Bright and Early, early medium, small, bright red, little rough.

Brintons Best, mid-season, medium size, red, usually smooth, firm and solid.

Buckeye State, mid-season, medium to large, purple, somewhat rough.

Combination, mid-season, large, rough, bright red, heavy yielder.

Cream City, mid-season, medium to large, purple, little rough.

Crimson Cushion, medium to late, large, purple, smooth, very desirable.

Crimson Robe, mid-season, large, purple, little rough.

Cumberland Red, mid-season, large to very large, red, rough.

Daybreak, mid-season, medium size, red, rough.

Democrat, mid-season, medium size, purple, nearly smooth, desirable.

Dominion Day, mid-season, medium to large, red, nearly smooth, excellent.

Dwarf Aristocrat, mid-season, medium size, red, little rough.

Dwarf Champion, early to medium, large, solid, purple, smooth, choice.

Earliana, extra early, small, red, little rough, choice, early.

Enormous, medium to late, very large, red, rather rough, coarse.

Excelsior, mid-season, medium size, purple, smooth, attractive.

Favorite, mid-season, large, purple, smooth, firm, good shipper.

Fordhook, mid-season, medium size, purple, smooth, attractive.

Freedom, early, small to medium, regular, scarlet, little rough.

Frogmore, mid-season, medium size, purple, smooth, pulpy.

Great Mississippi, medium, large, red, rough, coarse, productive.

Ignotum, early medium, large, red, smooth, choice quality.

Ignotum Potato Leaf, mid-season, medium to large, purple, smooth, excellent.

Long Island, mid-season, large, red, smooth, very productive.

Long Keeper, late, medium to large, purple, little rough.

Lorillard, early to mid-season, small to medium, red, smooth, choice for forcing.

Magnus, late, large, red, rather rough, very productive.

Mayflower, early medium, small, red, rough, very productive.

Minnesota, extra early, small, purple, smooth, a choice extra early.

Money Maker, mid-season, medium, red, rough.

New Imperial, mid-season, large, purple, smooth, very choice.

Northern Light, early, medium size, red, smooth, productive.

Optimus, mid-season, large, red, smooth, valuable.

Perfection, early, medium size, purple, smooth, regular, productive.

Ponderosa, late, very large, purple, smooth to rough, valuable.

Ponderosa Early, early, large, purple, smooth. A choice selected strain.

Quarter Century, mid-season, large, purple, smooth, desirable.

Quicksure, extra early, large, red, rough, very productive.

Red Granite, mid-season, medium size, purple, little rough.

Richmond, early to medium, small, red, rather rough.

Rosalind, mid-season, medium size, purple, usually smooth, solid, desirable.

Royal Red, mid-season, large, red, little rough, very productive, choice quality.

Ruby, early, small to medium, red, smooth, fine quality.

Shippers Delight, late, large, purple, little rough, desirable.

Stone, mid-season, medium size, red, smooth, solid, very desirable.

Ten Ton, mid-season, medium to large, red, smooth, of some value.

Thorburn Novelty, mid-season, large, round, red, rather rough.

Trophy, mid-season, large, dark red, smooth, solid, standard.

Truckers Favorite, mid-season, large, oval, smooth, red, solid, choice.

Twentieth Century, mid-summer, large, purple, little rough.

PRESERVING AND PICKLING SORTS.

Clusterosa, mid-season, small, yellow, pear shaped.

Egyptian Yellow, mid-season, medium size, yellow, rough.

Golden Prize, mid-season, medium size, yellow, smooth, one of the best.

Lemon Blush, mid-season, medium size, yellow, smooth, desirable.

Sumatra Egg, mid-season, small, yellow, rough.

White Apple, mid-season, small, white, smooth.

Yellow Pear, mid-season, small, yellow, smooth.

Yellow Peach, mid-season, small, yellow, rough.

NEW VARIETIES.

Boston Market, from R. and J. Farquhar and Co., is a very popular variety with eastern truck gardeners. It is very productive and medium early. The fruit is large, bright red, slightly corrugated about the stem, but smooth at the apex. It is solid, firm, and of excellent flavor.

Buckeye, from Landreth, is a large, smooth, red variety of good quality. It is very productive and seems to be identical with Livingston's Buckeye State, received from Vick's Sons. It is a very showy variety and is solid and smooth for so large a sort.

Burbank Preserving, received from Burpee, is a very small upright growing variety. The fruits grow in clusters like currants and are especially valuable for preserves.

Cardinal, from Salzer, is a spreading variety of great productiveness. The fruit is of a desirable size, bright red, firm and of good flavor.

Challenge, received from Mills, seemed to lack in productiveness, although the excessive growth of vines might be due to the wet season. The fruits were fairly smooth, bright red, and a little soft. In a dry season, the quality would probably be much improved.

Climax, from Burpee, is a medium-early purple variety of choice quality.

The vines are of moderate growth but carry a good amount of fruit. A choice sort for its season.

Crimson Whirlwind, from Salzer, is a very large red variety. The vines are strong and vigorous, but the fruit failed to properly ripen this season, or to develop any promising characteristics. It seemed to be rather rough.

Duke of York, from Bolgiano & Son, has vines averaging five feet in length with a spreading habit, which were loaded with fruit. The tomatoes are a bright, dark red color nearly purple, rather rough at the stem, but smooth otherwise. They averaged 6.25 ounces in weight and were firm and of fine flavor. Apparently rather late.

Dwarf Scarlet Champion, from Vaughan, seemed to be a selected strain of Dwarf Champion. They are attractive, productive and of good quality.

Early Leader, from Vick's Sons, is a quick maturing productive variety, but the fruit is too rough to be desirable. It is very similar to Vaughan's Earliest.

Early Tree, from the Great Northern Seed Co., is a dwarf variety. The fruits are regular, slightly seamed, red, and of good flavor.

Eclipse, from Weeber & Don, is a quick maturing, red variety of high quality. The vines have a spreading habit and average about four feet in length. The fruits average 4.18 ounces in weight, and are attractive in color and their smoothness and quality make them a most desirable early sort. They are said to be especially valuable for forcing.

Essex, from Farquhar & Co., is an early variety of some value, but it is not equal to the Eclipse. The fruits are bright red and fairly smooth.

Eureka, from Holmes, is an early, red, smooth variety, nearly identical with Essex. They resemble Ruby.

Fifty Day, from Salzer, is a dwarf, purple, smooth variety and it is nearly identical with Early Minnesota.

Futurity, Giant Everbearing and Illinois, were all received from the Great Northern Seed Co. Futurity is a large, red, smooth variety of good quality. It is much like Trophy. Giant Everbearing is an extra large, red variety, rather rough and coarse, and too soft to be of much value. Illinois is a medium-sized, purple, smooth variety that is both attractive and desirable.

Large Early and Matchless were received from W. A. Burpee & Co. Large Early is truly a large, early maturing, purple sort. The vines are vigorous and productive. The fruit is smooth and attractive but rather soft. This fault may be due partially to the wet season. Matchless is a bright red variety that is much liked in some sections. They are productive, smooth, solid and meaty, and ripen well through the season, beginning with the second early kinds.

Marvel and Table Queen were from Dreer. Marvel is a smooth, red variety of good quality. Table Queen is purple and is inclined to be a little rough about the stem, but the flesh is firm, solid, meat has a pleasant flavor. They are both strong growers and quite productive.

Melrose, and Waldorf were received from Holmes. Melrose is a quick growing and early maturing purple variety. The fruits are smooth and of good quality, but not numerous. Waldorf is very similar, except that the color is more of a rose tint and the season is a little later. It is more productive and the quality is about the same.

Michigan, from Ferry, is a choice second early variety. It is productive, smooth, meaty, of good flavor and has an attractive bright red color. Very desirable.

Model, from Vaughan, is an extra early bright red variety. The vines have an upright, but dwarf habit. They averaged only about two feet in height and were well loaded with fruit, of good quality. The plants can be set much closer than many other varieties.

Morning Star and Perfect Gem, were from Salzer. They are red varieties of some merit. Morning Star is a very large, and rough late sort. Perfect Gem is of medium size, smooth, meaty and of good quality.

New Glory, Redfield Beauty, and Wealthy were received from Bolgiano and Son. New Glory is a very large red variety but it did not become fully ripe. Redfield Beauty seems to be a selected strain of Beauty. Wealthy was one of the earliest varieties in the test. Some of the fruit was a little rough, but the bulk of it was round, solid, and meaty. It has a bright red color, and is of good quality. The vines were about forty-two inches long, stout and with spreading habit. Not very productive.

Niagara, introduced by John A. Bruce and Co., Hamilton, Canada, is a smooth, medium to large bright red variety; texture firm and meaty. The quality is good and its firmness makes it a good handler. The vines are thrifty and very productive.

Nolte's Earliest, also from Ferry, seems to be quite a choice early variety. Many of the fruits failed to properly ripen but the plants are vigorous growers and productive. The fruit is rather small, slightly rough at the stem, but solid and meaty.

Peachblow and President Cleveland were received from Farquhar. Peachblow. (Suttons), is a small, smooth purple variety. It is very productive and of good quality for its size, but it is too small for commercial use. President Cleveland is a slightly rough red variety. The vines are large coarse growers, and were loaded with large tomatoes, but they failed to fully ripen.

Princess, from Livingston Sons has a smooth, purple fruit with foliage of the Potato leaf type but is of no especial value.

Prizewinner and Queen were received from Griffith and Turner, Baltimore, Md. They are red varieties and are quite similar except in size, Prizewinner being the larger. They are productive and of good quality.

Early Jersey, from Landreth, is an extra early rather rough, red variety. The vines are very vigorous and productive.

Volunteer from Rawson, resembles Ruby except that it is larger. The vines are medium strong growers and productive.

Golden-Dome and Golden Queen are two of the most desirable yellow sorts. They are smooth, solid, meaty, of pleasant flavor and excellent for preserves.

Some of the seeds for the variety tests were received from the Department of Agriculture, Washington, D. C., others were saved by this department but most of them were obtained from the following seedsmen:

J. Bolgiano and Sons, Baltimore, Md.
John A. Bruce and Co., Hamilton, Canada.
W. Atlee Burpee and Co., Philadelphia, Pa.
John Lewis Childs, Floral Park, N. Y.
Currie Bros., Milwaukee, Wis.
Henry A. Dreer, Philadelphia, Pa.
Wm. Elliott and Sons, New York, N. Y.
J. A. Everitt, Indianapolis, Ind.
Farmer Seed Co., Faribault, Minn.
R. and J. Farquhar and Co., Boston, Mass.
D. M. Ferry, Detroit, Mich.
Ford Seed Co., Ravenna, Ohio.
Germaine Seed and Plant Co., Los Angeles, Cal.
Jas. J. H. Gregory, Marblehead, Mass.
Griffith and Turner Co., Baltimore, Md.
Joseph Harris Co., Moreton Farm, N. Y.
Peter Henderson and Co., New York, N. Y.
D. L. Holmes, Harrisburg, Pa.
Iowa Seed Co., Des Moines, Iowa.
D. Landreth and Sons, Philadelphia, Pa.
Livingston Seed Co., Columbus, Ohio.
Wm. Henry Maule, Philadelphia, Pa.
F. B. Mills, Rose Hill, N. Y.
Northrup, King and Co., Minneapolis, Minn.
W. W. Rawson and Co., Boston, Mass.
Wm. Rennie, Toronto, Canada.
John A. Salzer Seed Co., LaCrosse, Wis.
J. M. Thorburn and Co., New York, N. Y.
J. C. Vaughan, Chicago, Ill.
James Vicks Sons, Rochester, N. Y.
Weeber & Don, New York, N. Y.
T. W. Wood and Sons, Richmond, Va

BUSH FRUITS.

RASPBERRIES, 1902.

For the lack of a desirable location, the experimental varieties have been reduced until the list includes only a few of the better sorts. In the spring of 1901 a new plantation was set which will be reported as they come to fruiting maturity.

BLACK VARIETIES.

Coloma, produced a small amount of fruit for the first time. The canes are of fair growth. The berries are jet black, medium size and of good quality. Further trial is necessary to determine its real value. It is a mid-season thornless variety received from John Wenslick, Coloma, Michigan.

Cumberland is one of the most desirable varieties of recent introduction. The plants are very vigorous, healthy growers and seem to be very hardy. The fruit is a bright, black color, good size and has a sweet pleasant flavor. They average about eleven to the ounce in weight. The first fruit ripened July 2 and the last July 30, holding their size and quality well through the entire season.

Eureka is a desirable early sort. Ripened June 20. The canes are thrifty and healthy. In productiveness they rank well. The berries are medium to large, round, a little conical, pulpy and have a pleasant flavor. Averaged sixteen to the ounce.

Gregg is the most popular black-cap grown and suits itself to almost any conditions. With good culture; there are few superiors. The canes are strong, productive, and fairly hardy; berries attractive and of choice quality. Twelve to the ounce.

Kansas is a very productive variety largely grown for commercial purposes. The berries are of good quality and medium size. Averaged sixteen to the ounce. Ripened June 28 to July 26.

Lotta seems to be very susceptible to the rust and anthracnose. The berries are of good quality but the canes lack vigor.

Ohio. The canes are quite strong and healthy in growth and bear heavily. The berries are rather small, bright black, round, pulpy and of pleasant flavor. The period of ripening was June 29 to July 20. Averaged 30 to the ounce. Valuable for evaporating.

Pride of Ohio. It is not as productive as some of the other varieties but the berries are of a solid black color, firm and desirable. The canes are hardy, strong growers. Fruiting period July 6 to 24. Averaged 20 to the ounce.

Livingston produced medium-sized berries of fair quality. The canes are strong growers and productive.

Palmer. The berries average too small to be popular, ranking 29 to the ounce. The canes are spindling but seem healthy.

PURPLE.

Shaffer is the leading variety of this class. The canes are thrifty and productive. Berries loose and of medium quality.

Columbian is of better color and less subject to anthracnose.

RED VARIETIES.

Eaton received from Amos Garretson, Pendleton, Indiana. The canes are hardy, strong growers; fruit, dark red, oval, medium size and has a tendency to rattle some. The quality is not up to the Loudon or Cuthbert.

Harris. The fruit is of poor quality, and the canes have a short, stocky habit. The berries are of medium size, bright red, coarse, and crumble badly. The flavor is flat and insipid.

Loudon ranks as one of the standard red varieties. The canes are usually thrifty, and productive. This and the Cuthbert are two of the best red varieties.

Ridgeway was received from W. H. Ridgeway, Wabash, Indiana. The canes are very strong and thrifty growers, but the berries are few in number and small. The flavor and texture is good.

Gold, a yellow variety, was received from the same party. The canes are good growers and the berries are good for their class but there is no place on the market for them, the popular demand being for black or red berries.

Muskberry, a novelty, sent out by John Lewis Childs of Floral Park, N. Y., fruited for the first time this year. The canes are extremely rank growers, reaching eight to ten feet in height. They spread very badly from the roots and, like the strawberry-raspberry, are a decided nuisance in a garden. The fruit is of good size and attractive in appearance but the flavor is insipid and disagreeable. The bushes throw off a musky odor.

BLACKBERRIES.

The soil and location here is such that it is impossible to grow blackberries with any degree of success.

Rathbun, Mercereau, Hess and other improved varieties have been tried several times but they winter-kill every year.

Early Harvest seems to thrive as well as any variety and is very productive. The berries are of medium size and have a very small core. The flavor is pleasant.

Snyder and Taylor are two standard varieties that usually produce fruit of good quality in any section where blackberries can be grown.

CURRANTS.

In 1897 and 1898 several of the newer varieties of currants were planted, which have reached maturity from a fruiting standpoint.

Eclipse, received from H. S. Anderson, Elizabeth, New Jersey, has strong, vigorous, healthy bushes. The stalks are upright, stout, and

thickly covered with large leaves. The fruit stems are long and well-filled, containing 12-16 rather small dark-red fruits which have a slightly heavy, rich juice. The berries are rather small for fancy use but the quality is fine for jellies and they are very productive.

Empire, received from J. Lewis Childs, Floral Park, N. Y., seems to lack in hardiness as the bushes winter-kill some and do not recuperate readily. The berries are large, of a bright dark or ruby red, but the stems are short and contain only a few berries. The berries are of good quality and attractive but they are not productive enough to be profitable.

Filler, received from Jos. H. Black & Son, Hightstown, N. J. Originated in Ulster Co., N. Y. The bushes are very coarse, upright growers, with dark rank foliage. The clusters are of medium size, long, well-filled with bright red currants. They are good size, attractive and have a pleasant rich flavor.

London Market, received from Alexander Hamilton, Bangor, Michigan, is a promising variety for general cultivation. The berries are a little larger than the Pomona and have a bright clear red color. The juice is thick, heavy and of a pleasant sprightly flavor. The bushes are thrifty and vigorous but not quite as productive as Pomona.

Pomona, received from Albertson & Hobbs, Bridgeport, Ind. This has proven to be one of the best varieties of recent introduction. It is a vigorous thrifty grower and exceedingly productive. The clusters are long and filled with medium-sized berries having a mild, rich, pleasant flavor. The color of the fruit is a bright, clear red, becoming dark when fully ripened. They adhere firmly to the stems which prevents their massing in the boxes.

Purity, received from John Lewis Childs, Floral Park, N. Y. The bushes are low-growing and have a sprawling habit. The fruit is a yellowish white, but it is not equal to the White Transparent in quality or productiveness.

Red Cross, from Green's Nursery Co., Rochester, is another choice variety. The bushes are more upright and coarser than Pomona but not quite as productive. The berries are a little darker in color, and a trifle larger than Pomona but the stems are long and loosely filled. The quality is excellent.

Scarlet Gem is not what the name would signify, it being a pinkish-white currant. The bushes are low growers, coarse, and sparsely covered with foliage; stems long, fairly well filled with small, sub-acid, pleasant flavored berries.

White Transparent, received from Geo. S. Josselyn, Fredonia, N. Y., and White Versailles from John Charlton & Sons, Rochester, N. Y., are two choice white sorts resembling each other. The berries are about the same size and have a rich thick juice of a desirable sprightly flavor. The bushes are upright, strong growers and well loaded with fruit. The Transparent bunches are not quite as long as the Versailles but are a little more compact, which makes the productiveness about the same. The Versailles berries are a trifle larger but in general they are two varieties either of which could be selected as a choice white currant.

Wilder was received from Isaac Rogers, Dansville, N. Y., and is a seedling of Versailles. The berries are a little larger than Fays Prolific and of superior quality. The bushes are thrifty and productive. It is a valuable variety.

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GOOSEBERRIES.

In 1902, both the American and English varieties gave a good crop of fruit. The season was very wet and by spraying the English varieties with Bordeaux mixture early in the season, and following later with frequent sprayings of liver of sulphur (1 ounce to 3 gallons of water) the mildew was held in check so that the fruit was not seriously injured.

THE AMERICAN VARIETIES.

Downing for a green-colored berry is the most generally grown. It is hardy, of choice quality and over-productive. Some of the later varieties are larger but inferior in quality and can only be grown with the utmost care and attention. This is especially true of the English sorts.

Pearl and Red Jacket are two of the best newer sorts of the American varieties. They are thrifty, productive and of good quality.

Among the English varieties we have Chautauqua, Columbus, Industry, Keepsake and Lancashire. They have made medium to good growths but it is only by careful handling and weekly sprayings that we can mature the fruit. This is large, of choice quality, attractive but unless a grower has access to some good market, they are not profitable.

A new plantation was put out in 1901, including the best of the newer varieties and reports will be made on their behavior later.

Agricultural College, Michigan, February 21, 1903.

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DIVISION OF CHEMISTRY

FERTILIZER BULLETIN

BY

FLOYD W. ROBISON

AGRICULTURAL COLLEGE, MICHIGAN
1903

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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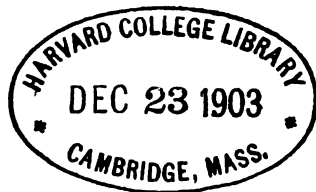
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FRANK S. KEDZIE, M. S., ... Associate Chemist	S. F. EDWARDS, M. S., Aast. in Bacteriology
B. O. LONGYEAR, B. S., ... Botanist	
MRS. L. E. LANDON, ... Librarian	

SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.



Michigan State Library.

FERTILIZER ANALYSES.

FLOYD W. ROBISON.

The sole use of commercial fertilizers is to supply the soil with food available to the growing plants. This object can also be attained by rendering more available the natural resources of the soil or by returning to the soil the natural manures produced on the farm. To each farmer comes the question whether he can afford to use commercial fertilizers. His first thought should be as to the natural resources of his soil. If his soil has an abundance of the fertilizing ingredients, it is not economy and is manifestly *poor farming* to add material which can be of no use, and may be of some harm and which, being subject to the leaching action of rain, is speedily lost. He should resort to commercial fertilizers only when the natural manures on his farm *fail* to supply the desired fertilizing ingredients. It is not economy to pay for fertilizing materials which the soil or the farm manure pile may themselves yield; but it is economy to use commercial fertilizers when the soil and the natural farm manures *fail* to return the equivalent of what is removed by the farm crops. It is not economy to supply fertilizers indiscriminately because they are called fertilizers, and many times in our own State has the righteous cause of the artificial fertilization of the soil been repudiated simply because the farmer who "tried it" did not take the pains to ascertain if the particular fertilizer he was using was the one adapted to his land. One could not expect to receive good returns for his investment if he applied a nitrogenous fertilizer to a soil already rich in nitrogen, nor could he expect a soil that had been liberally dressed with wood ashes for years to be much benefited by an application of a fertilizer high in potash. *A fertilizer containing a high percentage of potash is needed on that soil in which potash is deficient.* A consideration of the proper kind of fertilizer to be used depends also on the crop to be raised, for plants differ widely with respect to the particular ingredients upon which they draw heaviest in the soil.

AVAILABILITY OF FERTILIZERS.

In selecting a fertilizer two things should be kept in mind: first, the *total* amount of nitrogen, phosphoric acid and potash present, and second, the amount of nitrogen, phosphoric acid and potash *available*. Farmers always will seek and it is right that they should an immediate effect of the fertilizer used. With a soil that is *normal* in fertilizing constituents all that is necessary is to add in fertilizing material each year

the equivalents of what is removed by the crop. Such a soil requires a fertilizer whose constituents are all available, that is, ready for immediate use. Such a fertilizer would have its nitrogen in the form of nitrate of soda, or sulphate of ammonia, its phosphoric acid would be in the form of dissolved rock or dissolved bone, and its potash would be in the form of sulphate, muriate or carbonate. In this case, to supply the immediate needs of the growing crops should be the direct object of the use of fertilizers. In a soil *below the normal* in fertilizing constituents not only should the fertilizing requirements of the crop receive attention, *but the soil should be fed as well.* The building of the soil is accomplished by the application of fertilizers less readily available. Such fertilizers would have their nitrogen in the form of blood, tankage, cotton seed meal, bone meal, or digested leather. Their phosphoric acid would be in the form of raw bone meal, steamed bone meal or South Carolina rock. The availability of potash need not be a matter of concern for in most fertilizers it is equally available.

HUMUS.

All productive soils contain a considerable amount of organic matter, usually termed humus. An abundance of humus portrays a healthy condition of the soil, as far as the nitrogen supply is concerned. The supply of humus is kept up in two ways: first, by rotation with leguminous crops and green manuring. Second, by the liberal application of barnyard manure. Farmers do not yet sufficiently realize the extent to which they impoverish their land by a failure to return in barnyard manure the *organic* equivalent of what is removed by the crop. Commercial fertilizers will be used in vain, if the humic condition of the soil is not constantly replenished. *To better secure this end* it is well to consider commercial fertilizers as supplementary to the barnyard manure and in most instances they should be used in connection therewith.

THE ESSENTIAL PLANT REQUIREMENTS.

There have been proven to be thirteen elements more or less essential to plant growth. Of these, however, the agriculturists need be concerned for but three, namely, nitrogen, phosphoric acid and potash. All of the others are present in nearly all soils to a sufficient extent to satisfy the needs of vegetation. Just why and in what way these three ingredients are so essential is not known. What is known is that vegetation cannot exist in the absence of any one of the three. This suffices to explain the need of fertilizers. We are not as yet able to feed the plant, so to speak, we can but furnish the raw materials and the plant must do its own arranging and assimilating. Inasmuch as plants will not grow in the absence of available nitrogen, phosphoric acid and potash we know that these materials are essential. We then in commercial fertilizers furnish these three materials to the plant. It does its own arranging and building into such complex nitrogenous substances as "gluten."

NITROGEN.

Nitrogen is the element usually least abundant in soils and is the element most readily exhausted. It is also the most costly element to supply to the soil. Four-fifths of the volume of the atmosphere consists of nitrogen, but to most plants this enormous supply is of no consequence for they are entirely unable to assimilate it. A few plants belonging to the clover class are enabled, because of the small nodules on their roots, to change some of the atmospheric nitrogen into forms which can be utilized by the growing plant. This fact partly explains why a soil impoverished, from a nitrogen standpoint, is so benefited by turning under a heavy crop of clover as a green manure. Nitrogen is at the two extremes of nature. It is nitrogen that is so sluggish and inactive that it has been named "Azote, without life." Nitrogen does not support combustion, for if a flame is put into a jar containing nitrogen alone, the flame is at once extinguished. It is this same formerly inactive nitrogen, however, the various combinations of which form the deadliest explosives known. It is the compound of nitrogen that form some of the deadliest poisons known. It is nitrogen that makes nitroglycerin and dynamite such powerful and destructive agents. It is nitrogen that makes prussic acid one of the most deadly poisons known to man. It is this same nitrogen, another of whose combinations, is such an all-essential element of animal food *Protein*, or the albumen in eggs, the gluten in flour, the fibrin in meat, and the casein in milk, is the most essential constituent of animal food, and it is one of the various combinations of nitrogen. These considerations may serve to show in part why nitrogen is so essential and it is no wonder that its presence in the soil is of such vital interest to vegetable life. Nitrogen is found in fertilizers as *organic nitrogen* and as *salts of ammonia and nitric acid*. As organic nitrogen it is present in the scraps of meat, blood, vegetable matter, or leather; as a salt of ammonia it is present, chiefly, as ammonium sulphate. As a salt of nitric acid, it is present, chiefly, as nitrate of soda or Chili saltpeter. Nitrogen in the form of ammonium salts and nitric acid salts is the most readily available. Organic nitrogen must be disintegrated by agents in the soil before it can be made available to the plant. There are, however, differences in the availability of organic nitrogen from different sources. Nitrogen from blood, or seed meals, is much more readily available than is the nitrogen in leather and tankage made from garbage materials.

PHOSPHORIC ACID.

Phosphorus in plants and fertilizers is usually expressed in the form of phosphoric acid (P_2O_5). Phosphorus by itself is very inflammable and is also a deadly poison. When united with oxygen to form phosphoric acid it is not only harmless but essential to plant growth. It is usually found in fertilizers in combination with lime or it may be as free phosphoric acid in super-phosphate fertilizers. Phosphoric acid is recognized in fertilizers in three forms:

1. *Water-soluble phosphoric acid* gives us phosphoric acid in the free form as in true super-phosphates and as mono-calcic phosphate in which forms it is readily soluble in water.

2. *Citrate soluble phosphoric acid* gives us phosphoric acid in the form of what is commonly called reverted phosphoric acid. By reverted phosphoric acid is meant chemically di-calcic phosphate. This form is supposed to have been once soluble in water but after standing some time to have *reverted* or *gone back* to the di-calcic phosphate, hence its name, reverted phosphoric acid. This reverted or di-calcic phosphate is completely soluble in a solution of citrate of ammonia, hence its name, also, citrate-soluble phosphoric acid. In this form it is supposed to be readily available to plant growth and, therefore, in the Bulletin the water soluble and the citrate soluble are taken together and called "available phosphoric acid."

3. *Insoluble phosphoric acid*. In this form the phosphoric acid is as tri-calcic and tetra-calcic phosphate of lime and is completely insoluble in water and citrate of ammonia. It is not, therefore, immediately available to plants. Fertilizers containing their phosphoric acid in this condition should not be used where immediate results are expected, but they may be used to reclaim exhausted soils.

Generally speaking, the fertilizer of most value from a phosphoric acid standpoint is the one containing a relatively large proportion of available and a relatively small proportion of insoluble phosphoric acid.

SUPER-PHOSPHATES.

In true super-phosphates the phosphoric acid is all available. Super-phosphates are formed by treating insoluble bone and phosphate rock with sulphuric acid. The sulphuric acid combines with the lime forming sulphate of lime or gypsum, while the phosphoric acid being freed from its combination with the lime is rendered available. Super-phosphates are known in fertilizers also as acid phosphates.

POTASH.

Potash (K_2O) is a combination of the metal potassium (K) two parts with one part of the gas oxygen (O). Potassium in the free state is not known in nature for it has such an affinity for oxygen that it will destroy other substances to obtain their supply of oxygen. In contact with water it takes fire, thus decomposing the water and depriving it of its oxygen; it, like phosphorus, is not estimated in its pure state, but as potash.

Potash is a constituent of many rocks and in organic forms in vegetables it is quite abundant. Roots contain a large amount of potash. It is available to commerce, mainly in the forms of sulphate and muriate of potash. Wood ashes contain considerable amounts of potash (about 5%) in the form of carbonate of potash. Only one form of potash is recognized in fertilizers, and that is what is soluble in water.

USES OF NITROGEN.

1. Nitrogen gives a healthy growth to plants by promoting the formation of chlorophyll, or the green coloring matter of the stems and leaves.

2. It is useful in promoting leaf growth but if present in too large available quantities it retards maturing of the plant.

USES OF PHOSPHORIC ACID.

1. Phosphoric acid is useful in promoting seed formation and early maturity. In this respect it works antagonistic to nitrogen.

2. It promotes the formation of proteid material and is thus essential to plant nutrition.

USES OF POTASH.

1. Potash seems to play an important part in sugar formation by aiding in the transference of starches in plants. It is abundant in the sugar beet but excessive amounts are detrimental to the artificial recovery of sugar from the plant, because it prevents crystallization of the sugar.

2. It is essential to the development of the fleshy fruits and is important in the formation of the woody structure of the plant.

VALUATION OF FERTILIZERS.

The following prices may be used as representing quite closely the retail cost per pound of the ordinary forms of nitrogen, phosphoric acid and potash in chemicals and raw materials:

	Per pound.
Nitrogen in nitrates	\$0 15
Nitrogen in ammonia salts.....	17½
Nitrogen in organic matter.....	17
Phosphoric acid, available.....	04
Phosphoric acid, insoluble.....	02½
Potash as muriate.....	04½
Potash as sulphate	05
Potash as carbonate	05

The above valuations refer to the commercial value and not to the agricultural value of fertilizers. They simply refer to the market cost of the ingredients in the various forms as found in our large markets and as subject to market law of supply and demand. The agricultural value is quite a different thing and is a matter of variation on different farms.

CONCERNING GUARANTIES.

Farmers should note carefully that the maintenance of a guaranty has nothing whatsoever to do with the excellence of the fertilizer. It simply means that the manufacturer has set a standard and the Station has found the goods up to his mark. The law simply requires the manufacturer to guarantee the composition of his goods and he has complied with the law when these requirements are met. The maintenance of a guaranty is, therefore, not a proof of the value of the goods but simply shows that the manufacturer meets his claim.

SUPERFLUOUS GUARANTIES.

The law requires the manufacturer to print on the outside of the sack the guaranteed analysis of the fertilizer. Beyond this point the law is silent. It does not say what price shall be asked, neither does it place any limit on the guaranty. As a consequence manufacturers have in some instances covered nearly the whole front of the sack with guaranties, which cannot help being confusing and misleading. Below is printed an example of such a guaranty.

Nitrogen, 2 to 3%.
Nitrogen as ammonia, 2.43 to 3.6%
Moisture at 212 degrees F., 5 to 10%.
Reverted phosphoric acid, 2 to 6%.
Water soluble phosphoric acid, 6 to 8%.
Available phosphoric acid, 10 to 12%.
Total phosphoric acid, 12 to 14%.
Insoluble phosphoric acid, 0 to 2%.
Bone phosphate of lime, 24 to 27%.
Potash 2 to 3%.
Potash as sulphate, 3.7 to 5.5%.

The above reduced to its simplest form would be:

Nitrogen, 2%.
Available phosphoric acid, 10%.
Insoluble phosphoric acid, 2%.
Potash, 2%.

It seems hardly probable that manufacturers would go to the trouble of printing such a long array of guaranties if it were not advantageous for them to do so, and it is very probable that if two sacks were offered for sale one showing the first guaranty and the other showing the second, a great number of farmers would select the brand with the longer guaranty. The wants of the farmer would be *best* provided for if manufacturers would tabulate their guaranties in the simplest possible form. The Station will firmly endorse such a procedure.

Farmers should take notice also that the common way of expressing the guaranty as nitrogen 2 to 3% is a guaranty of but 2% nitrogen. Phosphoric acid 10 to 12% guarantees but 10% of phosphoric acid. The upper figure is of no import unless it be to signify a desire on the part of the manufacturer to claim more than he is willing to be responsible for.

TRADE NAMES.

Trade names, in so far as they designate the particular crop for which the fertilizer is to be used are misleading. Trade names should designate the material from which the goods are manufactured and not the crops for which they are to be used. Some fertilizers designated according to names as specially for one crop are frequently found under a different

name and advertised as a special manure for some entirely different crop. The fact that they are sold for what they are named simply proves that farmers look at the trade name instead of the analysis. There can *properly* be no such thing as special fertilizers for a particular crop. The needs of a crop depend upon the conditions of the soil in which they are grown. A fertilizer made especially for sugar beets on one farm may and in all probability will not be applicable to sugar beets grown on a different farm. What is needed is fertilizers showing varying amounts of the essential ingredients and graded accordingly. The farmer can then select that one which best conforms to his particular needs.

THE HOME MIXING OF FERTILIZERS.

In some states and by those farmers who have carefully studied the matter, home mixing of fertilizers has been highly successful. Home mixing is especially desirable where a special fertilizer is needed and one giving the desired composition is not offered for sale. With proper care farmers can make mixtures that meet their requirements by buying the raw materials and mixing them on the barn floor at home. This is commendable because it necessitates a study of soil conditions at home and thus the farmer puts on the land the exact fertilizer needed. It is not to be expected that such a fertilizer will be as thoroughly mixed as factory goods but it will be found sufficiently satisfactory and usually much cheaper.

THE MICHIGAN FERTILIZER LAW.

(Act No. 26 of the Session Laws of 1885.)

SECTION 1. *The People of the State of Michigan enact*, That any person or persons who shall sell or offer for sale in this State any commercial fertilizer, the retail price of which exceeds ten dollars per ton, shall affix on the outside of every package containing such fertilizer a plainly printed certificate, stating the number of net pounds therein; the name or trade mark under which such article is sold; the name of the manufacturer; the place of manufacture, and a chemical analysis, stating the percentage of nitrogen in available form; of potash soluble in water and of phosphoric acid in available form (soluble or reverted) and the insoluble phosphoric acid.

SEC. 2. Before any commercial fertilizer is sold or offered for sale, the manufacturer, importer or party who causes it to be sold or offered for sale within this State, shall file with the secretary of the State Board of Agriculture a certified copy of the analysis and certificate referred to in section one, and shall also deposit with said secretary a sealed glass jar, containing not less than two pounds of such fertilizer, with an affidavit that it is a fair sample of the article thus to be sold or offered for sale.

SEC. 3. The manufacturer, importer, or agent of any commercial fertilizer, the retail price of which exceeds ten dollars per ton as aforesaid, shall pay annually to the secretary of the State Board of Agriculture,

on or before the first day of May, a license fee of twenty dollars for each and every brand of fertilizer he offers for sale in this State: *Provided*, That whenever the manufacturer or importer shall have paid this license fee his agents shall not be required to do so.

SEC. 4. All such analyses of commercial fertilizers required by this act shall be made under the direction of the State Board of Agriculture and paid for out of the funds arising from the license fees provided for in section three. At least one analysis of each fertilizer shall be made annually.

SEC. 5. The secretary of the State Board of Agriculture shall publish in his annual report a correct statement of all analyses made and certificates filed in his office; together with a statement of all moneys received for license fees, and expended for analysis. Any surplus from license fees remaining on hand at the close of the fiscal year shall be placed to the credit of the experimental fund of said board.

SEC. 6. Any person or persons who shall sell or offer for sale any commercial fertilizer in this State without first complying with the provisions of sections, one, two, and three of this act, or who shall attach or cause to be attached to any such package or fertilizer an analysis stating that it contains a larger percentage of any one or more of the constituents or ingredients named in section one of this act than it really does contain shall, upon conviction thereof, be fined not less than one hundred dollars for the first offense, and not less than three hundred dollars for every subsequent offense, and the offender shall also be liable for damages sustained by the purchaser of such fertilizer on account of such misrepresentation.

SEC. 7. The State Board of Agriculture by any duly authorized agent is hereby authorized to select from any package of commercial fertilizer exposed for sale in this State, a quantity not exceeding two pounds, for a sample, such sample to be used for the purposes of an official analysis and for comparison with the certificate filed with the secretary of the State Board of Agriculture and with the certificate affixed to the package on sale.

SEC. 8. All suits for the recovery of fines under the provisions of this act shall be brought under the direction of the State Board of Agriculture.

Approved March 10, 1885.

The attention of manufacturers is called to Section 2 of the above law which requires to be filed with the secretary of the State Board of Agriculture a copy of analysis and certificate and also a sealed sample of the fertilizer *before such fertilizer is sold or offered for sale*.

Section 3 provides that on or before May 1st of each year the license fee shall also be deposited with the secretary. It is of mutual interest to the farmer and manufacturer that the Bulletin be published in time for the fall trade in fertilizers.

CHEMICALS.

All chemicals that are applied to the soil, such as sulphate of potash, muriate of potash, kainit, sulphate of ammonia, nitrate of soda or nitrate of potash, are considered as coming under the head of commercial fertilizers and as such are subject to the same conditions as other fertilizers.

The object of the law is the protection of the farmers and this cannot be given unless the entire field is covered. Dealers in these chemicals should see that they are properly labeled and licensed.

LEGAL GOODS.

The fertilizers, the analyses of which appear in this Bulletin, are the only fertilizers that can be lawfully sold in this State. Farmers and the granges should co-operate with the Station in securing evidence and samples of goods unlawfully on sale and by so doing the fertilizer law will fulfill the object for which it was intended; that is, the protection of the farmers.

Dealers in handling fertilizers should see that goods offered for sale bear the required license. If goods are offered for sale the analysis of which does not appear in the Bulletin an inquiry addressed to this division will secure prompt reply as to whether the goods can legally be sold.

It is a pleasure to acknowledge herewith the able and conscientious assistance of Mr. Lyman Carrier, B. Sc., who has aided much in the work of both inspection and analysis.

The following are the names of parties visited on the annual inspection for 1903:

Adair—Martin Blank, C. H. Lipke.

Allegan—B. F. Foster, Schuler & Born.

Almont—Hart & Sullivan, Frank Bishop.

Bay City—Jenison Hardware Co., R. C. Bialy, Presley & Layer, F. C. Goodine.

West Bay City—Geo. L. Frank, Geo. L. Mosher, Mohr Hardware Co.

Ann Arbor—John Heinzman.

Benton Harbor—H. E. Boehn, B. M. Nowlen & Co.

Berrien Springs—F. P. Ford.

Bad Axe—Lankin & Dundas, Wright, Freemont & Co., Harris Hardware Co., William Rapson & Sons, W. H. Carey & Co.

Birmingham—W. I. McClelland.

Brighton—A. C. Stewart, H. F. Hyne.

Buchanan—Pierce & Sanders.

Clio—Kent & Doyle & Fred Houghton, J. Wellman & Sons, G. W. Hubbard & Co.

Cassopolis—H. E. Moon, J. F. Hayden.

Chelsea—J. F. Barth, E. S. Spaulding, R. A. Snyder.

Constantine—Hutton & Barnard.

Coldwater—Randolph Bros., S. I. Treat & Son.

Corunna—Green & Pettibone.

Carsonville—Hartshorn & Anderson, C. J. Walker, H. Baird.

Coloma—Peck Bros., Stratton & Blackman.

Dundee—W. S. Wells.

Discoe—J. W. Switzer.

Dearborn—S. Baldwin.

Dowagiac—Edwin Corwin, F. H. Reshore.

Detroit—T. Feldman & Sons.

- Flint*—F. J. Hall & Co., Edwards Bros., R. Putnam & Co., E. A. Jennings, Moffett & Skinner.
Flushing—W. W. Mutton, Ottawa & Co., D. B. French.
Fennville—Geo. B. Meechem.
Grand Rapids—A. J. Brown Seed Co., Jones Seed Co., Perkins. Hess & Thompson.
Grand Haven—James Locke, Geo. Hancock & Sons.
Galesburg—Blake & Thomas.
Goodrich—Geo. Liscom.
Howell—W. L. Knapp & Son, Douglas Marr, Fred P. Schroeder, Asa Parshall.
Hart—H. P. Gephart.
Hartford—E. D. Goodwin.
Half Way—Frank P. Gerlach.
Hillsdale—Frank Whitney, G. N. Smith.
Holly—McLaughlin Bros., T. P. Morgan, M. F. Chase.
Ionia—Spaulding & Merritt.
Ida—Weipert & Couisno, Silas Kring.
Imlay City—Milo Quirk, J. W. Green, C. S. Marshall.
Jackson—S. M. Isbel & Co., Reid Implement & Seed Co., J. E. Bartlett.
Kalamazoo—Geo. W. Parker, S. D. Detmers, Woodhams Coal Co.
Kinde—J. H. Hall & Son, Wallace & Co.
Lenox—J. W. Patterson, Farmers Elevator Co., Richmond Elevator Co.
Linden—T. J. Winget & Sons, A. H. Buck & Sons, Judson Bros.
Lansing—C. Fitzsimmons, F. G. Dunning.
Laingsburg—C. D. Sharp, F. S. Lockwood & Co.
Lapeer—H. J. Willitt, Robert King, E. C. Roberts.
Marine City—Zimmerman Bros., H. H. Schneider.
Mt. Clemens—L. Houghton, John N. Tucker.
Marshall—H. J. Coleman.
Monroe—G. R. Hurd Sons Co.
Mt. Morris—J. H. Lewis, J. Lafurgey.
Maybee—H. Kohler.
Milan—W. P. Lampkin, F. G. Hasley, W. H. Hack.
Niles—W. J. Cameron, S. E. Bolten & Co.
Ocosso—O. F. Harryman, Ainsworth & Hanmer, W. E. Payne & Co., John Brooks & Sons, Hartshorn & Sons.
Pottersville—H. T. Spears.
Pontiac—Pontiac Ice & Fuel Co., W. M. Kirby, E. Holland & Son.
Port Huron—C. H. Kimball, M. D. Baldwin, C. B. Waterloo.
Petersburg—D. W. Smith, Lyons Bros., E. W. Spencer.
Quincy—Etheridge & Norton.
Reading—S. B. Mallory, Burlingame & Bowen, W. N. Cahow, N. Cane.
Rochester—Geo. Burr, H. J. Winans & Co., E. S. Letts.
Romeo—Hosner & Powell, Eaton, Bliss & Batholemew, Hulburt & Bancroft.
Romulus—Thos. W. McCloughy.
Saginaw—J. P. Derby, C. L. Roeser, Saginaw Beef Co.
St. Clair—E. C. Recor & Sons, G. C. Solus, W. R. Kemp.
Strasburg—C. M. Rau, Weipert & Meyer.
Sturgis—C. Cressler.
St. Joseph—E. Burton, G. K. Pixley.

Schoolcraft—W. J. Thomas, Pursel & Co.
Sanilac Center—William & Dell Dawson.
Shelby—C. F. Hale.
Sparta—Sparta Milling Co.
South Haven—Merrifield Implement Co.
Three Oaks—J. Wood Smith, E. C. Hamlin, Dr. O. Churchill.
Vandalia—F. G. Pollock.
Vicksburg—Vicksburg Lumber Co.
Wayne—Mr. VerDruin.
Wyandotte—Wayman Coal Co.
Ypsilanti—O. E. Thompson & Sons.
Zceland—I. Vandyke & Co., Henry Dekruif.

Results of analysis of commercial fertilizers for 1903, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.	Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
				Available.	Insoluble.	Total.	
210	The Armour Fertilizer Works, Chicago.	Bean Grower	.82 to 1.65 1.05	8 to 10 10.5	2 to 4 2.5	10 to 14 13	2 to 3 2.31
211	The Armour Fertilizer Works, Chicago.	Bone Meal	2.47 to 3.29 2.63	10 to 14 7.6	14 to 16 18.3	24 to 30 25.8	.....
212	The Armour Fertilizer Works, Chicago.	All Soluble	2.88 to 3.70 3.22	8 to 10 10.1	2 to 4 2	10 to 14 12.1	4 to 5 5.68
213	The Armour Fertilizer Works, Chicago.	Acidulated Bone Meal	1.64 to 2.47 2.36	11 to 14 19.1	7 to 10 2.4	18 to 24 21.5	.....
214	The Armour Fertilizer Works, Chicago.	Grain Grower	1.65 to 2.47 2.01	8 to 10 9.21	2 to 4 2.79	10 to 14 12	2 to 3 2.06
215	The Armour Fertilizer Works, Chicago.	Ammoniated Bone with Potash	2.47 to 3.29 2.88	6 to 8 7.4	2 to 4 1.1	8 to 12 8.5	2 to 3 2.29
216	The Armour Fertilizer Works, Chicago.	Wheat, Corn and Oats Special	.82 to 1.65 .83	7 to 9 8.16	2 to 4 2.14	9 to 13 10.3	1 to 2 1.16
217	The Armour Fertilizer Works, Chicago.	Bone, Blood and Potash.	4.11 to 4.94 4.69	8 to 10 10.22	2 to 4 3.18	10 to 14 13.4	7 to 8 6.47
218	The Armour Fertilizer Works, Chicago.	Phosphate and Potash.	.....	10 to 12 10.8	2 to 4 1.3	12 to 16 12.1	2 to 3 1.85
219	The Armour Fertilizer Works, Chicago.	Star Phosphate.	.....	14 to 16 13	2 to 4 1.9	16 to 20 14.9	.....
220	The Armour Fertilizer Works, Chicago.	Fruit and Root Crop Special	1.65 to 2.46 1.60	8 to 10 11.06	2 to 4 1.36	10 to 14 13	5 to 6

FERTILIZER ANALYSES.

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221	The Armour Fertilizer Works, Chicago.....	Sugar Beet Special.....	{ Claimed... { Found.....	.82 to 1.65 .91	8 to 10 10.37	2 to 4 1.08	10 to 14 12.3	4 to 5 3.80
222	The Armour Fertilizer Works, Chicago.....	High Grade Potato.....	{ Claimed... { Found.....	1.64 to 2.47 1.45	8 to 10 10.29	2 to 4 1.81	10 to 14 12.1	10 to 12 9.23
230	The Armour Fertilizer Works, Chicago.....	Steamed Bone Meal.....	{ Claimed... { Found.....	1.65 to 2.47 2.68	.....	20 to 22 23.7	20 to 22 23.7	.....
224	Tuscarora Fertilizer Co., Chicago.....	Bone and Potash.....	{ Claimed... { Found.....	.....	10 to 12 12.56	2 to 4 1.04	12 to 16 13.60	2 to 3 2.06
225	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Standard.....	{ Claimed... { Found.....	1.65 to 2.46 1.90	8 to 10 9.15	2 to 4 3.61	10 to 14 12.76	2 to 3 4.05
226	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Trucker.....	{ Claimed... { Found.....	4.11 to 4.94 3.72	8 to 10 9.20	2 to 4 2.16	10 to 14 11.86	7 to 8 8.86
227	Tuscarora Fertilizer Co., Chicago.....	Wolverine Special.....	{ Claimed... { Found.....	.82 to 1.64 .69	8 to 10 8.91	2 to 4 1.30	10 to 14 10.30	4 to 5 5.24
228	Tuscarora Fertilizer Co., Chicago.....	Michigan Special.....	{ Claimed... { Found.....	1.64 to 2.46 1.60	8 to 10 8.1	2 to 4 1.6	10 to 14 9.7	5 to 6 4.45
229	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Fruit and Potato.....	{ Claimed... { Found.....	1.64 to 2.47 1.84	8 to 10 7.6	2 to 4 1.1	10 to 14 8.7	10 to 12 9.28
230	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Bone Phosphate.....	{ Claimed... { Found.....	.....	10 to 12 9.9	2 to 4 9	12 to 16 10.8	.....
231	Tuscarora Fertilizer Co., Chicago.....	Acid Phosphate.....	{ Claimed... { Found.....	.....	14 to 16 16.33	2 to 4 1.17	16 to 20 17.5	.....
232	Tuscarora Fertilizer Co., Chicago.....	Ammoniated Phosphate.....	{ Claimed... { Found.....	.82 to 1.66 1.05	7 to 9 4.8	2 to 4 2.6	9 to 13 7.4	1 to 2 1.15

Results of analysis of commercial fertilizers for 1903, expressed in parts in a hundred.

Laboratory No.	Manufacturer.	Trade name.	{ Claimed... Found. }	Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
					Available.	Insoluble.	Total.	
233	Tuscarora Fertilizer Co., Chicago	Tuscarora Garden	{ Claimed... Found. }	2.88 to 3.70 2.77	8 to 10 9.45	2 to 4 2.35	10 to 14 11.8	4 to 5 4.91
223	Tuscarora Fertilizer Co., Chicago	Steamed Bone Meal	{ Claimed... Found. }	1.65 to 2.46 3.59	8 to 10 6.22	12 to 14 18.96	20 to 24 25.18	.....
234	The Jarecki Chemical Co., Sandusky, O.	Lake Erie Fish Guano	{ Claimed... Found. }	.86 to 1.64 1.66	10 to 12 11.96	1 to 2 2.89	11 to 14 14.75	2 to 3 1.13
235	The Jarecki Chemical Co., Sandusky, O.	Number One Fish Guano	{ Claimed... Found. }	.86 to 1.64 .97	10 to 12 9.73	1 to 2 1.5	11 to 14 11.25	1 to 2 1.04
236	The Jarecki Chemical Co., Sandusky, O.	C. O. D. Phosphate	{ Claimed... Found. }	.....	14 to 15 17.66	1 to 2 1.44	15 to 17 19.1	.....
237	The Jarecki Chemical Co., Sandusky, O.	{ Fish and Potash, Potato and Tobacco Food }	{ Claimed... Found. }	.86 to 1.64 .93	8 to 9 6.9	1 to 2 7.2	9 to 11 14.1	4 to 5 4.49
239	The Jarecki Chemical Co., Sandusky, O.	Special Sugar Beet Grower	{ Claimed... Found. }	.86 to 1.64 .90	8 to 9 10.2	1 to 2 4.7	9 to 11 14.9	4 to 5 3.84
240	Darling & Co., Chicago	Darling's Acid Phosphate	{ Claimed... Found. }	.....	10 to 12 14.62	46	10 to 12 15.1	.....
241	Darling & Co., Chicago	Darling's Chicago Brand	{ Claimed... Found. }	1.65 to 2.50 1.78	8 to 10 8.02	2 to — 8.73	10 to — 16.75	2 to 3 2.55
242	Darling & Co., Chicago	Darling's Western Brand	{ Claimed... Found. }	.41 to .82 .59	7 to 9 9.27	2 to — 1.93	9 to — 11.2	.50 to 1 .896
243	Darling & Co., Chicago	Darling's Pure Bone and Potash	{ Claimed... Found. }	2.16 to 2.88 3.86	.....	..... 25.2	20.13 to 22.75 25.2	6 to 7 8.62

244	Darling & Co., Chicago.....	{ Darling's Two and Twenty Bone..... }	{ Claimed... Found..... }	1.60 to 2.50 2.47			18 to 22 23.4	
245	Darling & Co., Chicago.....	{ Darling's Farmers' Favorite Brand..... }	{ Claimed... Found..... }	2.43 to 3.29 2.51	8 to 10 10.02	2 to 5 6.58	10 to 15 16.6	4 to 5 8.22
246	Darling & Co., Chicago.....	Darling's Sure Winner Brand.....	{ Claimed... Found..... }	.82 to 1.65 1.01	8 to 10 10.25	2 to 5 3.85	10 to 15 14.1	3 to 4 3.53
247	Darling & Co., Chicago.....	Darling's Pure Ground Bone.....	{ Claimed... Found..... }	2.50 to 3.30 3.17		27.3	23 to 26 27.2	
248	Swift & Co., Chicago.....	Sugar Beet Grower.....	{ Claimed... Found..... }	2.50 to 3.25 2.63	8 to 10 10.75	3 to 5 2.35	11 to 15 13	5 to 6 4.79
249	Swift & Co., Chicago.....	Bone Meal.....	{ Claimed... Found..... }	2.50 to 3.25 3.45		36	25 to 27.50 26	
250	Swift & Co., Chicago.....	Bone and Potash.....	{ Claimed... Found..... }	2.50 to 3.25 2.11		27.15	23.50 to 26 27.15	3 to 4 3.51
251	Swift & Co., Chicago.....	Onion, Potato and Tobacco.....	{ Claimed... Found..... }	1.64 to 2.47 1.67	8 to 10 7.09	3 to 5 4.81	11 to 15 11.9	7 to 8 6.33
252	Swift & Co., Chicago.....	Special Phosphate and Potash.....	{ Claimed... Found..... }		10 to 12 10.9	1 to 2 2.3	11 to 14 13.2	2 to 3 1.98
253	Swift & Co., Chicago.....	Superphosphate.....	{ Claimed... Found..... }	1.64 to 2.47 1.56	8 to 10 6.69	4 to 8 6.01	12 to 18 13.6	2 to 3 2.09
254	Swift & Co., Chicago.....	Complete Fertilizer.....	{ Claimed... Found..... }	1 to 1.75 1.01	8 to 10 8.94	3 to 5 3.56	11 to 15 12.5	1 to 2 1.17
255	Swift & Co., Chicago.....	Swift's Vegetable Grower.....	{ Claimed... Found..... }	3.25 to 4 3.34	9 to 11 9.74	1 to 3 3.66	10 to 14 13.4	10 to 11 8.49
256	Swift & Co., Chicago.....	Swift's Lawn Fertilizer.....	{ Claimed... Found..... }	3.75 to 4.50 3.86		24.45	23 to 27.50 24.45	

Results of analysis of commercial fertilizers for 1903, expressed in parts in a hundred.

Laboratory No.	Manufacturer.	Trade name.	Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
				Available.	Insoluble.	Total.	
257	Chicago Fertilizer Co., Chicago..	Bone, Blood and Potash.....	1.24 to 2.06 1.01	8 to 10 9.63	2 to — 3.37	10 to — 13	2 to 3 2.56
258	Chicago Fertilizer Co., Chicago..	Wheat and Corn Special.....	.82 to 1.64 1.06	7 to 9 7.28	1 to 2 2.12	8 to 11 9.4	1 to 2 1.72
259	Chicago Fertilizer Co., Chicago..	Potash Special.....	.82 to 1.65 1.02	8 to 10 9.3	2 to — 4.9	10 to — 14.2	4 to 5 5.41
260	Ohio Farmers' Fertilizer Co., Columbus, O.....	{ Corn, Oats and Wheat Fish { Guano.....	1.24 to 2.06 1.32	8 to 10 10.63	2 to — 3.37	10 to — 14	2 to 3 5.84
261	Ohio Farmers' Fertilizer Co., Columbus, O.....	Ammoniated Bone and Potash	.82 to 1.64 1.06	8 to 10 11.06	2 to — 3.85	10 to — 14.9	4 to 5 5.37
262	Ohio Farmers' Fertilizer Co., Columbus, O.....	General Crop Fish Guano.....	.82 to 1.64 1.24	7 to 9 10.33	1 to 2 3.37	8 to 11 13.7	1 to 2 2.62
263	Grand Rapids Glue Co., Grand Rapids, Mich.....	Grand Rapids.....	3 to 5 2.41	6 to 7 4.24	6 to 8 8.11	12 to 15 12.35	1 to 2 .994
264	The American Agricultural Chemical Co., New York City	{ Bradley's Alkaline Bone and { Potash.....	.....	11 to 13 8.6	1 to 2 2.5	12 to 15 11.1	2 to 3 2.13
265	The American Agricultural Chemical Co., New York.....	Bradley's Niagara Phosphate.	.82 to 1.65 1.11	7 to 9 8.9	1 to 2 2.3	8 to 11 11.2	1 to 2 1.39
266	The American Agricultural Chemical Co., New York.....	{ Crocker's New Rival Am- { moniated Superphosphate.	1.23 to 2.05 .88	9 to 11 8.86	1 to 2 1.44	10 to 13 10.3	2 to 3 2.16
267	The American Agricultural Chemical Co., New York.....	{ High Grade Garden and Veg- { etable Fertilizer.....	2 to 3 2.33	8 to 11 7.56	 1.25	8 to 11 8.8	6 to 8 6.80.

FERTILIZER ANALYSES.

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268	The American Agricultural Chemical Co., New York.....	{ Crocker's Ammonia'd Wheat and Corn Phosphate..... }	{ Claimed..... } { Found..... }	2.08 to 3 2.06	8 to 10 8.64	1 to 2 1.16	9 to 12 9.8	1.5 to 2.5 1.26
269	The American Agricultural Chemical Co., New York.....	{ Crocker's Dissolved Bone and Potash..... }	{ Claimed..... } { Found..... }	.....	10 to 12 10.06	1 to 2 2.06	11 to 14 12.7	2 to 3 1.08
270	The American Agricultural Chemical Co., New York.....	{ Crocker's Universal Grain Grower..... }	{ Claimed..... } { Found..... }	.82 to 1.64 .97	8 to 10 8.06	1 to 2 1.44	9 to 12 9.5	3 to 3 2.60
271	The American Agricultural Chemical Co., New York.....	{ Bradley's B. D. Sea Fowl Guano..... }	{ Claimed..... } { Found..... }	2.08 to 2.88 2.01	8 to 10 8.64	2 to 3 .96	10 to 13 9.6	1.5 to 2.5 2.14
272	The American Agricultural Chemical Co., New York.....	{ Bradley's Soluble Dissolved Bone..... }	{ Claimed..... } { Found..... }	.....	14 to 16 17.3	1 to 3 .7	15 to 18 18	.....
273	The American Agricultural Chemical Co., New York.....	{ Bradley's Dissolved Bone with Potash..... }	{ Claimed..... } { Found..... }	1 to 3 1.11	8 to 10 9.4	2 to 3 .7	10 to 13 10.1	2 to 3 2.09
274	The American Agricultural Chemical Co., New York.....	{ Crocker's General Crop Phosphate..... }	{ Claimed..... } { Found..... }	.82 to 1.64 .98	7 to 9 7.5	1 to 2 1.5	8 to 11 9	1 to 2 2.66
275	The American Agricultural Chemical Co., New York.....	{ Crocker's Ammoniated Bone Superphosphate..... }	{ Claimed..... } { Found..... }	2.46 to 3.28 2.46	9 to 11 8.9	1 to 2 1.7	10 to 13 10.6	2 to 3 1.08
276	The American Agricultural Chemical Co., New York.....	{ Niagara Dissolved Bone and Potash..... }	{ Claimed..... } { Found..... }	.....	10 to 12 11.15	1 to 2 1.96	11 to 14 13.1	2 to 3 2.08
277	The American Agricultural Chemical Co., New York.....	{ Niagara Grain and Grass Grower..... }	{ Claimed..... } { Found..... }	.82 to 1.64 .93	7 to 9 6.9	1 to 2 2.6	8 to 11 9.5	1 to 3 2.88
278	The American Agricultural Chemical Co., New York.....	{ Niagara Wheat and Corn Producer..... }	{ Claimed..... } { Found..... }	1.23 to 2.05 1.18	9 to 11 9.7	1 to 2 2	10 to 13 11.7	2 to 3 2.43
279	The American Agricultural Chemical Co., New York.....	{ Niagara Potato and Vegetable Fertilizer..... }	{ Claimed..... } { Found..... }	2.05 to 3 2.29	8 to 10 8.6	1 to 2 1.3	9 to 12 9.9	3 to 4 2.44
280	The American Agricultural Chemical Co., New York.....	{ Fine Ground Bone..... }	{ Claimed..... } { Found..... }	2.47 to 3.30 2.32	.....	24 24.47	22.80 to 25 24.87	.....

Results of analysis of commercial fertilizers for 1903, expressed in parts in a hundred.

Laboratory No.	Manufacturer.	Trade name.		Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
					Available.	Insoluble.	Total.	
228	Michigan Carbon Works, Detroit	{ Homestead, a Bone Black Fertilizer..... }	{ Claimed..... { Found..... }	2.06 to 2.88 2.30	8 to 11 9.21	 1.44	8 to 11 10.65	1.5 to 2.5 1.92
228	Michigan Carbon Works, Detroit	{ Homestead, Potato and Tobacco Fertilizer..... }	{ Claimed..... { Found..... }	2.06 to 2.88 2.13	8 to 11 7.66	 1.44	8 to 11 9.1	3 to 4 2.36
224	Michigan Carbon Works, Detroit	{ Homestead, Sugar Beet Fertilizer..... }	{ Claimed..... { Found..... }	1.23 to 2.06 1.14	9 to 11 9.47	 1.93	9 to 11 11.4	2 to 3 4.08
225	Michigan Carbon Works, Detroit	Red Line Complete Manure.....	{ Claimed..... { Found..... }	.82 to 1.65 1.08	7 to 10 8.47	 2.33	7 to 10 10.8	1 to 3 1.86
226	Michigan Carbon Works, Detroit	{ Red Line Phosphate with Potash..... }	{ Claimed..... { Found..... }	.....	10 to 12 10.1	 3	10 to 12 13.1	2 to 3 2.07
227	Michigan Carbon Works, Detroit	Red Line Phosphate.....	{ Claimed..... { Found..... }	.....	14 to 16 17.3	 1.2	14 to 16 18.5	.....
228	Michigan Carbon Works, Detroit	Wolverine Phosphate.....	{ Claimed..... { Found..... }	.....	10 to 13 9.5	 2	10 to 13 11.5	.....
229	Michigan Carbon Works, Detroit	Banner Dissolved Bone.....	{ Claimed..... { Found..... }	.....	30 to 34 35.6	 3.2	30 to 34 38.2	.....
230	Michigan Carbon Works, Detroit	Dessicated Bone.....	{ Claimed..... { Found..... }	*1.24 to 2.06 1.46	.....	..... 38.3	25 to 30 38.3	.....
231	Michigan Carbon Works, Detroit	Pure Animal Bone and Potash.....	{ Claimed..... { Found..... }	.82 to 1.05 1	.....	..... 38.3	22 to 26 33.3	6 to 8 2.84
232	Northwestern Fertilizer Co., Chicago.....	Garden City Superphosphate.....	{ Claimed..... { Found..... }	2.05 to 2.87 2.44	8 to 10 8.13	2 to 3 2.07	10 to 13 10.2	1.5 to 2 1.10

FERTILIZER ANALYSES.

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293	Northwestern Fertilizer Co., Chicago	{ { Horseshoe Brand Corn and Wheat Grower. } }	{ Claimed. Found. }	1.64 to 2.26 1.64	8 to 10 9.80	2 to 3 2.01	10 to 12 12.9	2 to 2.5 2.11
294	Northwestern Fertilizer Co., Chicago	{ { Horseshoe Brand Potato Grower. } }	{ Claimed. Found. }	2.46 to 3.29 2.86	9 to 10 9.5	2 to 3 1.7	11 to 13 11.2	2 to 3 2.23
295	Northwestern Fertilizer Co., Chicago	Actulated Bone and Potash.	{ Claimed. Found. }	.82 to 1.64 .94	10 to 12 11.56	2 to 3 2.24	12 to 15 12.8	1 to 1.5 1.49
296	Northwestern Fertilizer Co., Chicago	Quick Acting Phosphate	{ Claimed. Found. }	.....	10 to 12 11.59	2 to 3 1.01	12 to 15 12.6	.....
297	Northwestern Fertilizer Co., Chicago	{ { Horseshoe Brand Sugar Beet Fertilizer. } }	{ Claimed. Found. }	1.23 to 2.05 1.26	9 to 11 10.8	1 to 2 1.6	10 to 12 12.4	2 to 3 2.89
298	Grange Fertilizer Co., Detroit	{ { Michigan Grange Acid Phos- phate 10%. } }	{ Claimed. Found. }	.....	10 to 12 10.25	 2.15	10 to 12 12.5	.....
299	Grange Fertilizer Co., Detroit	{ { Michigan Grange Acid Phos- phate 14%. } }	{ Claimed. Found. }	.....	14 to 16 15.9	 1.4	14 to 16 17.3	.....
300	Grange Fertilizer Co., Detroit	{ { Michigan Grange Wheat and Oats Special. } }	{ Claimed. Found. }	2.08 to 2.98 2.27	8 to 11 7.8	 1.7	8 to 11 9.5	2.5 to 3.5 1.73
301	Grange Fertilizer Co., Detroit	{ { Michigan Grange Corn, Oats and Gram. } }	{ Claimed. Found. }	1.65 to 2.5 1.85	8 to 10 7.5	 1.7	8 to 10 9.2	2 to 3 2.27
302	Grange Fertilizer Co., Detroit	{ { Michigan Grange Complete Manure. } }	{ Claimed. Found. }	.82 to 1.65 .98	7 to 10 7	 2	7 to 10 9	1 to 2 1.09
303	Spiegel & Swartz, Grand Haven, Mich.	Celery Hustler	{ Claimed. Found. }	7 to 8 7.08	3.17 to 3.4 1.13	.69 to 1.41 2.9	3.85 to 4.81 4.08	1.25 to 2.25 2.16
304	The Cincinnati Phosphate Co., Cincinnati, O.	Capitol Wheat Grower	{ Claimed. Found. }	.....	14 to 15 13.6	1 to 2 3.5	15 to 17 17.1	.....

* Ammonia 1.50 to 2.50.

Results of analysis of commercial fertilizers for 1903, expressed in parts in a hundred.

Laboratory No.	Manufacturer.	Trade name.		Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
					Available.	Insoluble.	Total.	
305	The Cincinnati Phosphate Co., Cincinnati, O.	Capitol Grain and Grass Grower	{ Claimed... { Found.....	.82 to 1.04 .83	10 to 12 13.3	1 to 2 1.8	11 to 14 15.1	1 to 2 1.35
306	The Cincinnati Phosphate Co., Cincinnati, O.	{ Capitol Dissolved Bone and { Potash.....	{ Claimed... { Found.....	.....	12 to 13 15.1	1 to 2 2	13 to 15 17.1	3 to 4 3.78
307	The Cincinnati Phosphate Co., Cincinnati, O.	Capitol Alkaline Bone.....	{ Claimed... { Found.....	.....	10 to 11 11.5	1 to 2 3.4	11 to 13 14.9	2 to 3 2.15
308	The Cincinnati Phosphate Co., Cincinnati, O.	Capitol Tobacco Food.....	{ Claimed... { Found.....	.82 to 1.04 .79	1 to 9 9.6	1 to 2 4.3	9 to 11 13.7	4 to 5 3.65
315	The Hardy Packing Co., Chicago	Hardy's Crop Producer.....	{ Claimed... { Found.....	.82 to 1.04 .90	7 to 9 7.58	2 to 3 3.42	9 to 12 11	1 to 2 2.05
316	The Hardy Packing Co., Chicago	{ Hardy's Tankage Bone and { Potash.....	{ Claimed... { Found.....	1.23 to 2 1.31	8 to 10 8.14	2 to 3 3.90	10 to 13 12.1	2 to 4 3.44
317	James Boland, Jackson, Mich.	Bone Meal.....	{ Claimed... { Found.....	14.04 3.48	3.66 10.15	15.52 12.85	19.18 23	.....
318	James Boland, Jackson, Mich.	Blackman.....	{ Claimed... { Found.....	2.5 to 3.5 1.91	10 to 12 1.4	.90 to 1 7.6	10.9 to 13 9	3 to 4 3.95
320	Kalamazoo Rendering and Fertilizer Co., Kalamazoo, Mich.	Kazoo Brand.....	{ Claimed... { Found.....	*6.1 5.85	1.99 2.15	8.79 7.25	10.78 9.4	.....

* Ammonia 7.4.
+ Ammonia 4.91.

The following analyses are inserted inasmuch as numerous letters are received yearly requesting information on the goods mentioned in this table. These analyses are not original with this bulletin, but are compiled from various sources and represent a great variety of conditions. The averages here given should therefore represent more closely the average farmer's condition than would specific and individual analyses:

Authority.	Product.	Nitrogen.	Phosphoric acid.	Potash.
Landwirtschaftlicher Kalender, 1896	Fresh barnyard manure.	0.39%	0.18%	0.45%
" "	Well rotted manure.....	0.58%	0.30%	0.50%
" "	Fresh horse manure.....	0.58%	0.28%	0.53%
" "	" cow "	0.44%	0.17%	0.35%
" "	" sheep "	0.83%	0.23%	0.67%
" "	" hog "	0.45%	0.19%	0.60%
U. S. Dept. Agriculture, 1894.....	" hen "	1.10%	0.85%	0.56%
Roberts—Fertility of Land.....	" horse urine.....	1.55%	.....	1.50%
" " "	" cow "	0.58%	.....	0.49%
" " "	" sheep "	1.95%	.....	2.26%
" " "	" hog "	0.43%	0.83%	.....
Michigan Experiment Station	Wood ashes, unleached. ....	.....	1.68%	4.24%
" " "	" " leached....	.....	1.43%	0.36%
Soils and Fertilizers—Snyder.....	Hard coal ashes.....	.....	0.10%	0.10%
" " " "	Soft " " .....	.....	0.40%	0.40%

SPECIAL BULLETINS.

Number.

- 2—Pests of house and ornamental plants.
- 4—Apple orchard spraying, when and how.
- 5—Forecast of frost.
- 7—San Jose scale.
- 8—Planting sugar beets.
- 9—Farm accounts.
- 10—Sugar beets.
- 13—A review of Prof. Bangs' work on contagious abortion.
- 14—Foul Brood.
- 16—Aeration of Milk.
 - When and What to Spray.
 - Prevention of Potato Scab.
 - Elementary Science Bulletin, numbers 1 to 18.
- 17—Mosquitoes and other insects of year 1902.
- 18—Sugar beets in Upper Peninsula.
- 19—Spraying Calendar 1903.

BULLETIN NO. 211

APRIL, 1904

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DIVISION OF CHEMISTRY

BREAKFAST FOODS

BY

FLOYD W. ROBISON

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

MICHIGAN AGRICULTURAL EXPERIMENT STATION

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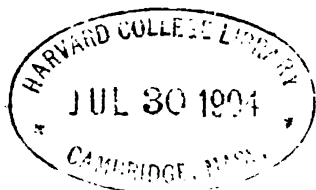
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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 100 acres deeded.



Mich. State Library.

INTRODUCTORY NOTE.

The analytical data appearing in this bulletin have been in preparation for two years as time would allow. Not all the cereal breakfast foods were examined but only such as were obtainable in our markets. It is believed that types of all or nearly all classes are shown in this report.

In presenting this bulletin to the public, it has been considered advisable to divide the matter into two parts: part one to be a short popular discussion of the Compounds and Laws of Nutrition, and part two to consist of the more or less technical analytical data and the deductions therefrom, together with an appendix showing some of the methods of analysis.

While the foregoing remarks apply especially to seeds of clover, alfalfa, and the grasses, they are also applicable in a measure to larger seeds such as corn, beans, oats, wheat, sugar beet, etc.

PRELIMINARY EXAMINATION FOR IMPURITIES.

In making an examination of any sample of seed a person should be supplied with a few inexpensive articles all of which, with perhaps the exception of a lens, can be found in any home. The lens may be any

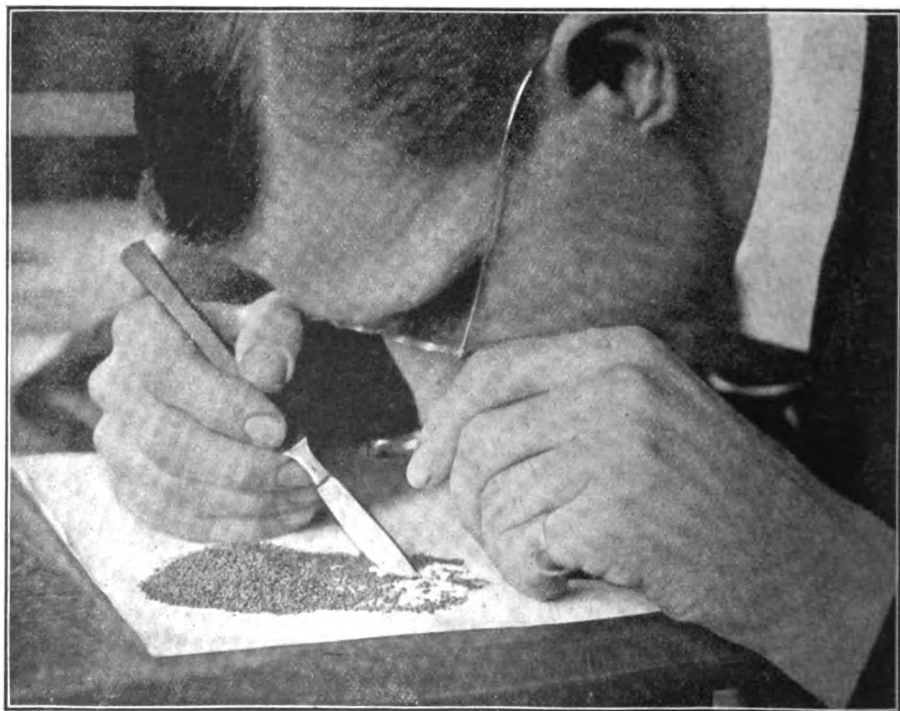


Fig. 1.—Examining clover seed for impurities and weed seeds. Place the eye close down to the lens.

simple pocket magnifier giving an enlargement of about five to ten diameters. Such lenses can often be purchased at jewelry stores or the local optician's for twenty-five cents, for a single lens, or forty to fifty cents for two lenses. A sheet of foolscap or other smooth white paper and a fruit knife or pocket knife complete the outfit for this work. The paper may have the edges turned up about one-fourth of an inch which will prevent the seeds from rolling off during examination.

For the examination of clover, alfalfa and similar seeds one or two tablespoonfuls of seed should be placed in a pile on one side of the paper, which should be laid on a table near a window. Then, holding the lens in one hand, with the knife blade draw small quantities of the seed from the edge of the pile, spread them out so that each one can be readily

seen and examine them carefully through the lens. Remove all foreign material, including the weed seeds to one corner of the paper while the remaining clean seeds are pushed to one side. Continue this process until all of the sample has been thoroughly sorted. Two piles have now been formed, one consisting of clean seed, the other of impurities containing the weed seeds.

If a delicate balance were at hand it would now be possible to determine the per cent of impurities by weighing both piles and dividing the weight of the impurities by the weight of the sample before sorting. However, it is possible to gain some idea sufficient for a rough estimate by

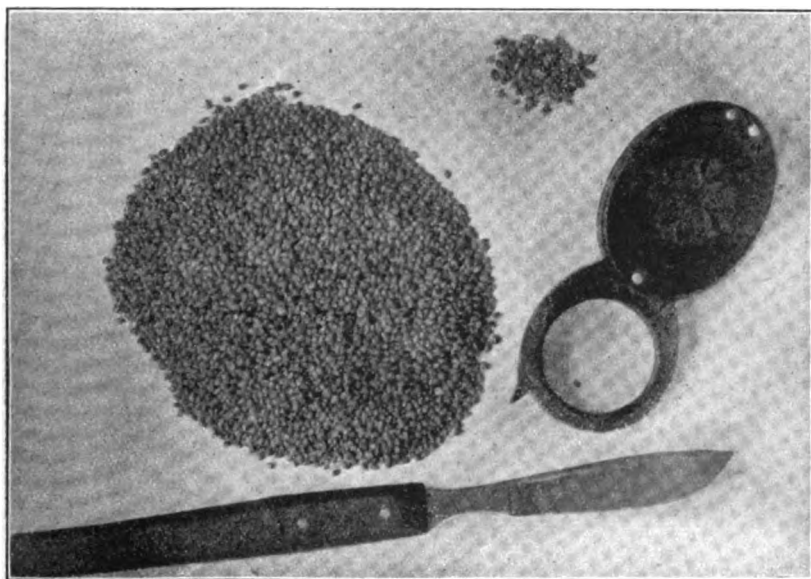


Fig. 2.—Clover seed and weed seeds separated. In the sample shown the weed seeds constituted a little over one per cent of the total weight of the sample.

comparing the size of the two amounts. The weed seeds may be carefully saved in a small dish or vial for further examination and a sample of the clean seed counted out for a germination test.

THE GERMINATION TEST.

The value of this test will depend to a considerable extent upon the care with which it is performed. The necessary articles are a soup or dinner plate, with a somewhat smaller plate or a pane of glass for covering it, and some pieces of rather thick, clean cloth. For one or two samples of small seeds a tea saucer covered with a piece of window glass will be found ample, while the cloth, when folded, may be about three by four inches in size.

The seed for testing is first to be thoroughly mixed and one hundred seeds counted out, taking them just as they come, regardless of size or

plumpness, the idea being to get as nearly as possible an average sample. A piece of the cloth is now dipped in water until thoroughly wet, then squeezed partly dry, after which the counted seeds are to be sprinkled over one half of the cloth and the other half folded over upon the seeds. This is placed in the larger plate and covered with the smaller plate or the piece of glass to prevent drying out. If thin cloth is used it should be folded across two or three times in opposite directions to secure sufficient thickness.

Prepared in this way several samples may be placed in the same dish which is to be kept in a room where the temperature is comfortable for a person to live, and where the night temperature does not fall much

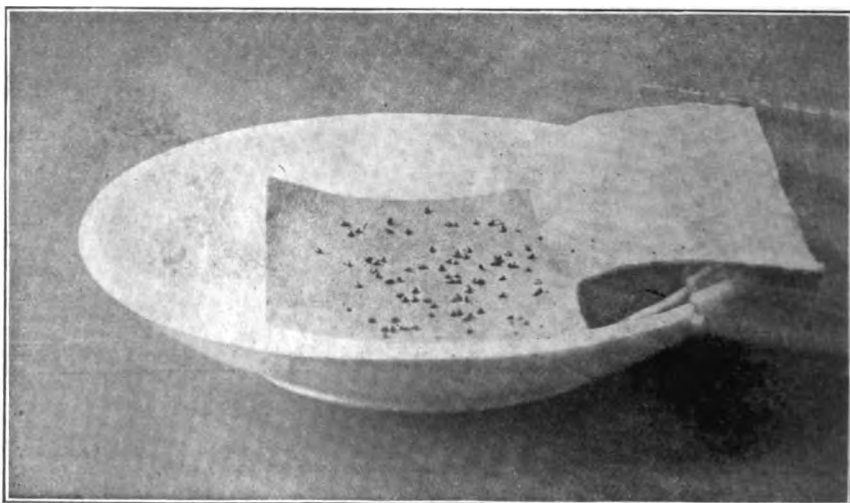


Fig. 3.—Testing for vitality; one hundred seeds placed on a fold of the moistened cloth.

below 50°. By using a larger number of seeds the accuracy of the test is increased, however, it is well to use some number, like one hundred, which enables one to readily estimate the per cent of vitality. If two or more lots of seeds are being tested in the same dish they should be carefully labeled to avoid mistakes. This may be done by marking a number on the cloth with ink or colored pencil, before wetting, this number to correspond with a similar number on a sheet of paper. This sheet should also have a record of the date when the seeds were placed in the tester. The seeds may be examined every twenty-four hours, the seeds which have germinated and have sprouts about one-fourth inch long being removed, counted and recorded on the sheet of paper, after which they are thrown away. At the end of ten days the total number of seeds which have sprouted out of a hundred, will represent the per cent of vitality of the seed. Some seeds do not sprout as quickly as others and the length of time for making the test will need to be somewhat lengthened. Thus with sugar beet seed it is customary to allow fourteen days for the com-

pletion of the test, although the number sprouted at the end of one week is estimated.

With large seeds like those of corn, peas, beans, etc., a little time may be gained by soaking in water for a few hours before placing them in the tester. The cloth should not be kept too wet or the seeds will tend to rot but if they are getting too dry, a little water may be sprinkled on the cloth. If it is desired to use the cloth again for testing seeds it should be dipped for a few minutes in boiling water to destroy any molds which may be growing on it. A soup plate of sand may also be used for testing seeds, especially large ones. In this case the seeds may be placed on the sand, which has been moistened and leveled, and covered with about one-

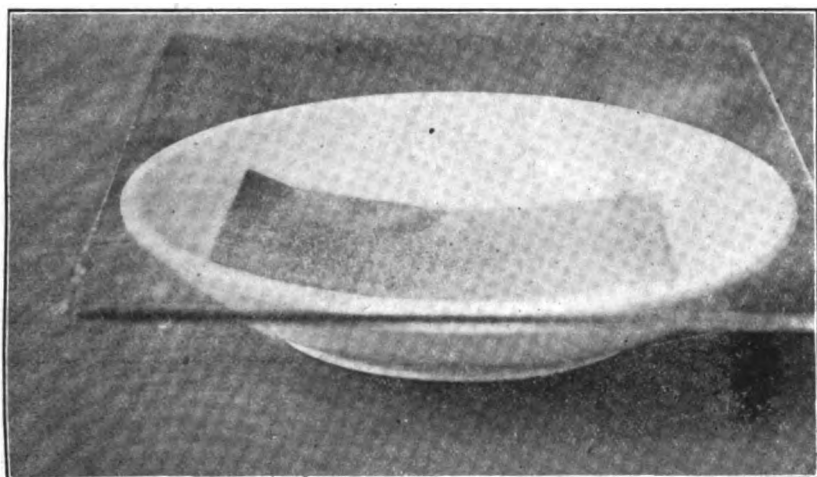


Fig. 4.—The seeds folded in the cloth and covered with a plate of glass.

fourth to one-half inch of sand and again moistened, or they may be laid on the leveled sand and covered with a moistened piece of cloth, the whole to be covered with a pane of glass.

Blotting paper and filter paper may also be used in place of cloth with very satisfactory results. This is the usual method pursued by the writer in seed testing, the paper used being a thin, gray absorbent paper much like that used by druggists for filtering liquids. This paper is first folded in several thicknesses marked and moistened, after which the seeds are sprinkled between a fold and placed in the testing plate.

EXAMINING THE WEED SEEDS.

The weed seeds which have been separated from the sample of clover, alfalfa or other seed under examination, should be carefully sorted under the lens, and identified if possible. This work requires careful attention to details, in order to be satisfactory, and the person with little or no botanical training may not expect to do much in the naming of the weed seeds which will be found. However, it will be possible for many

persons to identify some of the more common weed seeds which occur in clover and alfalfa and which would be a nuisance if sown on a field not previously infested.

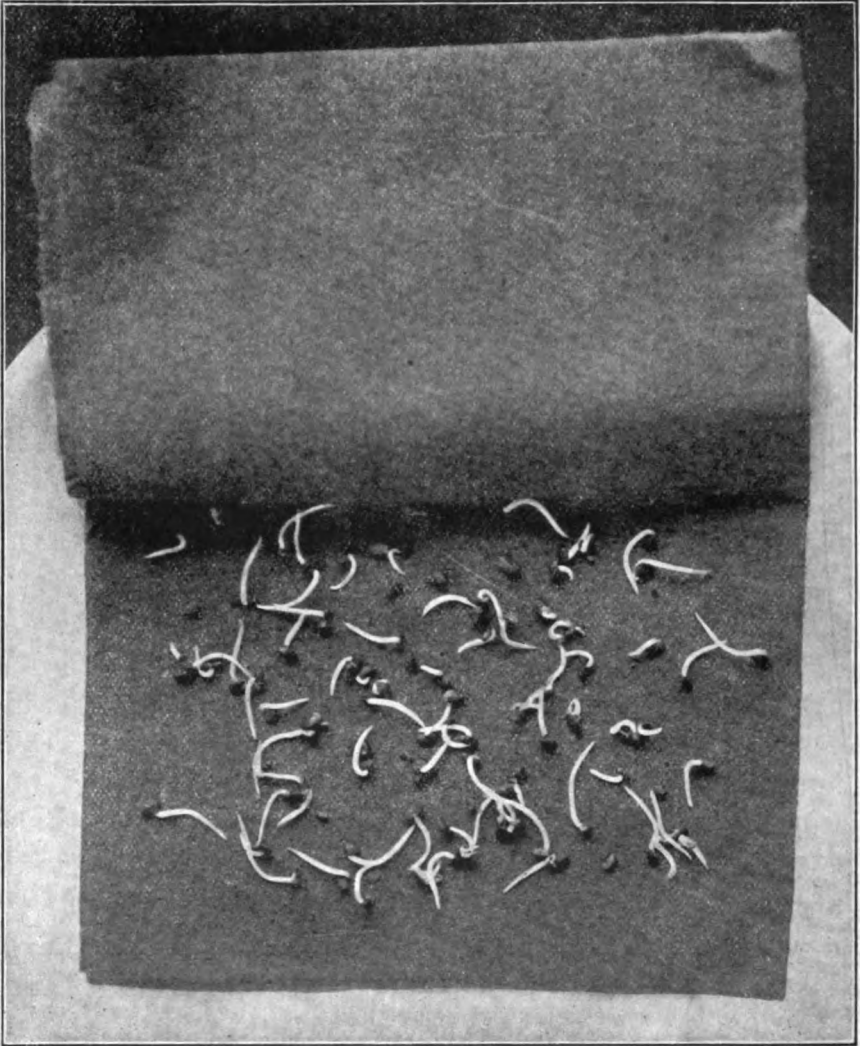


Fig. 5.—The seed germinated and ready to be counted.

In order to make this naming of weed seeds as easy as possible figures from photographs are shown of a few of the most importance. These figures are enlarged to about the same extent as if they were being seen through a low power lens. Short descriptions of each kind of weed seed shown are also given and these should be carefully studied in connection with the picture.

This work of identification should be done by daylight if possible, the weed seeds being placed on a sheet of smooth white paper on a table, near a window. The lens, if without other support, should be held with one hand at the proper distance from the seeds and the eye placed close down to the lens. Then with a small bladed pocket or pen knife, or even a sliver of wood, the seeds may be sorted, those of one kind being placed together. A record should be kept of the number of seeds of each kind found in the sample and if a known part of a pound has been used the total number of weed seeds in a bushel may be estimated.

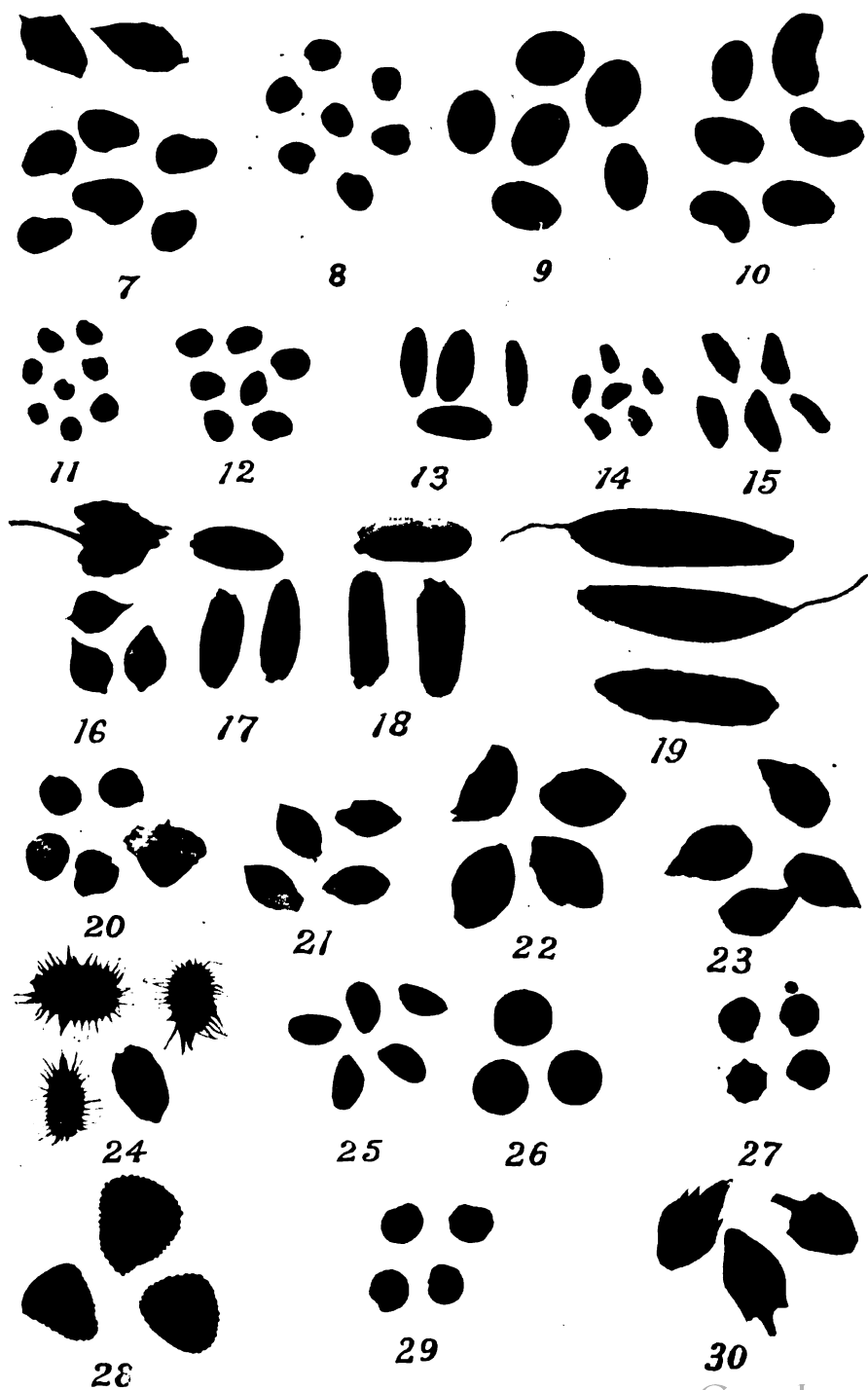
Most weed seeds can be distinguished from the seed with which they are mixed by some difference in size, shape, markings on the surface, and color. In some cases, however, the difference is so slight as to make it difficult for an inexperienced person to tell them apart. This is especially true in the case of seeds of dodder or "Love vine" which sometimes occur in western grown clover and alfalfa seed. In fact seed known to come from the west or from Europe should always be carefully examined for these weeds. Two species of dodder are to be looked for in clover and especially in alfalfa seed. These plants have the habit of growing as parasites upon the plants about them. They are very simple little vine-like plants without leaves but consisting of slender, yellowish, wiry stems which twine about the clover and alfalfa plants causing them to die down. Sometimes whole fields of alfalfa are destroyed or severely weakened by the presence of these parasitic vines, hence the presence of their seeds in clover and alfalfa seed becomes a serious menace to the growing of these forage plants.

Fortunately the seeds of the more common of these two dodders, (*Cuscuta epithymum*) are considerably smaller than those of alfalfa and red clover seed hence can be successfully removed by screening with a sieve of twenty meshes per linear inch. The seeds of the other dodder, however, (*Cuscuta arvensis*) are sometimes as large as the smaller seeds of clover and alfalfa, hence screening cannot be entirely relied upon in this case without sacrificing much seed. It is advisable, therefore, to reject any seed in which the seeds of this dodder are found.

Where dodder has been seeded with clover or alfalfa its presence will be indicated by the appearance of more or less rounded, spreading areas in which the plants are dying down, and if examined at close range the thread-like twining stems of the dodder will be found covering them. These areas can be readily seen even at some distance as they present a yellowish or light orange colored appearance. When discovered the plants within this area and for a couple of feet beyond should be cut, allowed to dry and burned, or straw may be spread on these spots and burned to destroy the dodder and prevent its forming seeds.

The Russian thistle is another pest which is being disseminated by means of Western grown seed, and while the plant may not prove to be a serious weed on loam and clay, it is gaining a foothold in the sandy portions of our state.

Another very common and vile weed found in clover and alfalfa seed is the narrow leaved plantain or "buckhorn" plantain. Its seeds are so nearly the same size as those of clover that they can be removed only with persistent recleaning. A near relative and of common occurrence is the broad-leaved plantain. In both cases the seeds can be quite readily recognized and seed containing them even in moderate amounts should be avoided.



- Fig. 7.—Red clover, the two uppermost enclosed in the little pod.
- Fig. 8.—Alsike clover.
- Fig. 9.—Crimson clover.
- Fig. 10.—Alfalfa.
- Fig. 11.—Clover dodder, love vine, (*Cuscuta epilimum*). Surface dull or minutely scurfy; color greenish gray, yellowish or brownish; often irregularly flattened, with a minute scar at one end.
- Fig. 12.—Field dodder (*Cuscuta arvensis*) shaped much like the preceding but larger; surface dull or slightly scurfy; color yellowish, reddish or brownish. The color of these seeds so closely resembles that of alfalfa as to make their separation exceedingly difficult. The surest way to identify suspected dodder seeds is to soften them in water and carefully open them with needles mounted in handles: The embryo plant of the dodder seeds is slender and coiled up inside of a floury material, while the embryo of a clover or alfalfa seed much resembles that of a bean.
- Fig. 13.—Narrow-leaved plantain, Rib grass, Buckhorn, plantain. (*Plantago lanceolata*). Somewhat boat-shaped, with a small scar on the grooved side; surface smooth, shining; color light brown, often with a lighter stripe along the convex side.
- Fig. 14.—Broad-leaved plantain. (*Plantago Major*.) Shape angular, flattened; surface minutely rough and dull; color brown or brownish with a minute whitish scar on one side.
- Fig. 15.—Rugel's plantain. (*Plantago Rugellii*.) Much like the above but somewhat larger and darker in color, being almost black with a conspicuous light scar on one side.
- Fig. 16.—Curled dock. (*Rumex crispus*.) With the calyx removed these resemble small kernels of buckwheat, being triangular and with a smooth, polished surface; color reddish brown.
- Fig. 17.—Canada thistle. (*Carduus arvensis*.) Shape somewhat angled lengthwise and often slightly curved with a small scar at smaller end, larger end cup-like with a small central projection; surface smooth but not polished; color light to dark brown.
- Fig. 18.—Bull thistle. (*Carduus lanceolatus*.) These are much like the preceding but slightly larger and more often yellowish or light grayish in color.
- Fig. 19.—Chaff. (*Bromus secalinus*.) These appear slightly like small kernels of oat, but sometimes possess a short spine or awn. The chaff encloses a reddish grain which is folded lengthwise and has a dull surface.
- Fig. 20.—Russian thistle. (*Salsola Tragus*.) These are often found enveloped with a dry calyx of a light gray color. When this is rubbed off the seed (fruit) resembles somewhat in form a chocolate drop with a concave base, in the center of which is a minute point. Surface dull, color grayish brown; embryo plant coiled in the seed.
- Fig. 21.—Green foxtail. (*Chaetochloa viridis*.) The grains are usually partly enveloped with the thin, membranous chaff which is yellowish or greenish gray; the enclosed grain is brownish, mottled with a darker brown; surface dull except two narrow polished stripes along the edges of the flattened side.
- Fig. 22.—Yellow foxtail, Pigeon Grass. (*Chaetochloa glauca*.) These are larger and lighter colored than the preceding, the chaff being greenish while the grain is mostly yellowish or brownish and transversely wrinkled.
- Fig. 23.—Redroot, Wheat-thief. (*Lithospermum arvense*.) Shape somewhat conical with a convex base; surface roughened with irregular ridges and tubercles; color grayish, with the convex base nearly black.
- Fig. 24.—Wild carrot. (*Daucus carota*.) Shape flattened with one side convex and bearing four rows of light colored spreading spines; color brownish. As found in clover seed the spines have in most cases disappeared, the convex side showing four light colored lines lengthwise.
- Fig. 25.—Peppergrass. (*Lepidium virginicum*.) Shape much flattened, with a thin, narrow margin and a groove extending part of its length on each side; surface dull; color light brownish red.
- Fig. 26.—Wild turnip. (*Brassica campestris*.) Shape nearly spherical; surface smooth but dull; color purplish brown or blackish with a very small light scar.
- Fig. 27.—Lamb's quarters pigweed. (*Chenopodium album*.) These are at first enclosed in a dry closely fitting envelope which breaks away in places exposing the smooth, shiny, black seed which is flattened-convex.
- Fig. 28.—Corn cockle. (*Agrostemma githago*.) These appear to be folded upon themselves; surface rough with points arranged in rows; color brownish black.
- Fig. 29.—Evening catchfly. (*Silene noctiflora*.) These are much smaller than the preceding but otherwise resemble them somewhat in shape and surface; color grayish brown.
- Fig. 30.—Ragweed. (*Ambrosia artemisiifolia*.) These are somewhat egg-shaped with a pointed projection surrounded with a crown of several tooth-like points at the large end; surface dull and slightly ridged; color yellowish, grayish or brown, often somewhat mottled.

BULLETINS NOS. 213-214

MAY, 1904

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DIVISION OF HORTICULTURE

213—SMALL FRUITS FOR 1904

214—TOMATOES AND POTATOES

BY L. R. TAFT AND M. L. DEAN

AGRICULTURAL COLLEGE, MICHIGAN
1904

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.

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SMALL FRUITS FOR 1904.

NOTES ON THE STRAWBERRY.

BY L. R. TAFT AND M. L. DEAN.

Although the strawberry thrives under a great variety of conditions, it does best upon a moderately heavy, sandy loam or a light clay loam soil. While an abundance of moisture is required for the best results, care should be taken to have the soil fairly well drained so that water will never stand upon the land and the soil will dry out quickly in seasons when showers are frequent. For the purpose of supplying plant food as well as keeping the land uniformly moist, it should contain a considerable amount of humus, and there is no better way of fitting land for this crop than to turn under a heavy clover sod. The use of liberal amounts of stable manure is also advisable, but if it is not thoroughly decomposed it is advisable to apply it one year in advance and use the land for some hoed crop. Thirty or forty-two horse loads per acre can often be used to advantage on the average soil. As a partial substitute for the manure, good results will be obtained from 50 to 100 bushels of unleached, hardwood ashes. If there is a fair amount of humus in the soil profitable returns can often be secured from the use of commercial fertilizers as a source of plant food. Many of the mixed complete fertilizers sold by the manufacturers for the purpose, will be found very satisfactory. An equal amount of plant food, however, can generally be secured for a much smaller sum and one will be more likely to obtain what is ordered if the chemicals are obtained and mixed on the farm. By mixing from 100 to 200 pounds of nitrate of soda, 200 to 300 pounds of muriate of potash, 200 to 300 pounds of ground bone and 200 to 300 pounds of acid phosphate, an excellent fertilizer will be produced for one acre of land. After the land has been plowed and thoroughly dragged it should be rolled if the soil is loose. After rolling it would be a good plan to loosen the surface with a smoothing harrow.

The distance for setting the plants will depend a good deal upon the method of culture. If to be grown in hills, the distance may be 24 inches each way or the plants may be set 36 by 12 to 15 inches. This method, however, is only desirable for the fancy trade and with a few varieties. Ordinarily the plants are set in rows from 3½ to 4 feet apart and from 2 to 3 feet in the rows. This will make it possible to cultivate the land both ways for a number of weeks and thus save considerable hand labor. One objection to setting the plants closer than this in the rows is that they will, under favorable conditions, soon fill in the rows and if the runners are not cut off they will be turned in either direction by the cultivator and taking root, form a thick mat.

13. December, 1899, Review of Bang's Work With Contagious Abortion, C. E. Marshall.
14. June, 1900, Foul Brood, C. D. Smith and J. M. Rankin.
15. March, 1902, Spraying Calendar, L. R. Taft.
16. June, 1902, Aeration of Milk, C. E. Marshall.
17. February, 1903, Mosquitoes and Insects of Year, 1902, R. H. Pettit.
18. March, 1903, Upper Peninsula Sugar Beets, C. D. Smith and L. M. Geismar.
19. May, 1903, Spraying Calendar, L. R. Taft.
20. August, 1903, Report of U. P. Sub-station for Years 1901 and 1902, C. D. Smith and L. M. Geismar.
21. September, 1903, Cheese Problems, John Michels.
22. January, 1904, The Crop of Corn, J. A. Jeffery.
23. January, 1904, A Preliminary Note on the Associative Action of Bacteria in the Souring of Milk and in Other Milk Fermentations, C. E. Marshall.
24. February, 1904, Insects Injurious to Fruits, R. H. Pettit.
25. March, 1904, Fungous Diseases of Fruit, B. O. Longyear.
26. April, 1904, Spraying Calendar, L. R. Taft.
27. May, 1904, Report of South Haven Sub-station, T. A. Farrand.
28. May, 1904, Report of Upper Peninsula Sub-station, L. M. Geismar.
29. May, 1904, The Associative Action of Bacteria in Milk, C. E. Marshall.

Of this list, numbers 1, 3, 6, 12 and 19 are out of print. *As long as the supply lasts, copies of these special bulletins, not out of print, will be sent free to those who apply for them.* Hereafter the number and title of each special bulletin will be given in the first regular bulletin issued after its publication. This bulletin calls attention to special bulletins No. 24, No. 25 and No. 26. All three relate to the enemies of fruit trees in Michigan and suggest remedies. The special bulletins themselves should be in the hands of all farmers owning orchards or other fruit plantations, as it is impossible in the limits of this bulletin to fitly review them or to do more than name some of the most conspicuous diseases and remedies.

THE APPLE.

No fungous disease is reported as doing serious injury to the roots of this tree. The woolly aphid attacks the roots and is treated by a liberal use of tobacco dust or wood ashes, and it is good practice to dip young stock in water at 130° F., kerosene emulsion or tobacco water, before setting out.

The bark of the tree is attacked by the oyster-shell bark-louse, the eccentric scale, the San Jose scale, and the scurfy bark-louse. Various remedies are suggested for these several insect pests in special bulletin No. 24. Professor Pettit does not deem the presence of even the San Jose scale, widely distributed as it is over the State, as a menace sufficiently grave to discourage the progressive fruit grower. Fortunately for him the peril is sufficiently ominous to discourage the half-hearted and incompetent orchardist and to leave the business of apple growing in Michigan in the hands of men of sufficient energy and intelligence to guard their orchards against these pests even at the expense of the frequent sprayings and the bothersome methods which their unwelcome presence makes necessary.

Two borers affect the trunk of the apple and the pear tree, and one of them at least the peach. Professor Pettit suggests eternal vigilance as the price of the early discovery of the depredations of these insects, and the use of a stiff pin, a knife and a wash of strong soap and soda, as the best cures.

When we come to the branches of the tree the number of enemies increases. Here we have to deal with the apple scab, canker, black rot, twig blight, fire blight, buffalo tree-hopper and the apple twig-borer. The bulletins under discussion give the latest discoveries concerning these diseases and the best remedies as yet suggested. The relation between the rots of the fruit and those peculiar scars upon the bark of the limbs and even of the trunk that used to be called "sun scald," is pointed out and its significance made clear. In the same way the relation of the apple scab to diseases of the leaves and bark, and the importance of ridding the orchard in late fall of diseased fruit, still clinging to the twigs, and of the dead leaves upon the ground, is pointed out. One advantage supposed to be on the side of cover crops as against bare ground was that the former would collect and hold the leaves as well as the snow and thus add manure to the soil as well as provide a covering for the roots. Recent discoveries have shown that the leaves provide a home for certain diseases through the winter, a resting place from which they may issue the following spring to attack the tender leaves, the twigs and even the fruit itself.

The leaves of the apple tree are the most tender and succulent part of its anatomy. These two bulletins point out three fungous diseases and name sixteen species of insects that feed upon them. Fortunately the remedies suggested for fighting these diseases are not great in number nor difficult to manufacture and apply. The insects, for the most part, are poisoned by sprays of paris green, combined with bordeaux mixture, applied to ward off the fungi.

The fruit is attacked by at least six different species of fungi. Some of them utterly destroy, as the bitter rot and the ripe rot. Others disfigure, as the apple scab, which opens the road for the rots. All of them are avoided by early, frequent and judicious spraying.

Three species of insects attack the fruit, but their depredations are very largely avoided by sprayings with paris green.

THE PEAR.

What has been said of the apple and its enemies may in a large measure be said of the pear, although this fruit suffers more keenly from diseases that are less hostile to the apple and from others which do not affect the apple at all. The pear requires more care in Michigan than the apple, perhaps even more intelligent, persistent and painstaking attention to ward off the ever present enemies. These bulletins report six insects as affecting the bark, two the trunk, one the branches, seven the leaves, and three the fruit. The fungous diseases attack principally the leaves and fruit, spreading to the newer and more tender twigs.

THE QUINCE.

The quince has some fungous diseases all its own, diseases very injurious if not fatal to the plant, but of a kind, with two exceptions, yielding readily to judicious spraying.

THE PEACH.

The peach is the fruit which grows to perfection along the west coast of the State and yields a profit even in the interior counties. The immense revenues accruing to Michigan citizens from the sale of peaches is lessened and its very existence threatened by certain serious diseases. Among these, easily the worst, is the yellows, the nature of which is not understood and the remedy not forthcoming. The same is true of the little peach. All that can be done is to educate the eye to detect the first symptoms and the will to destroy every affected tree. The other ills are not past spraying for.

The roots are attacked by a disease allied to the fungi, called crown gall, and by an insect which bores into them; the bark suffers from the dreaded San Jose scale, the English-walnut scale, the peach lecanium, the fruit bark beetle and the eccentric scale; the trunk, from the flat-headed apple tree borer and the divaricate buprestid; the limbs, from the peach twig borer, the tree hopper and the tree cricket; the leaves, from the black peach aphid, the climbing cut worm and the striped peach worm among insects, and the leaf curl, mildew, shot-hole fungus and leaf spot among fungous diseases. The fruit must be protected against the brown rot, the scab, rust, mildew, brown spot, and even against the codling moth and plum curculio.

THE PLUM.

The plum has almost as many enemies as the peach, the same borer attacks the roots, the European fruit scale and the apricot scale its bark, the flat-headed borer its trunk, the shot-hole fungus its leaves and the brown rot its fruit. It has some diseases of its own, like gummosis of the limbs, plum pockets in the fruit and twigs, and the curculio and gouger in the fruit. It suffers, too, with the tent caterpillar, the canker worm, bud moth and rose chafer in its leaves.

THE CHERRY.

The diseases of the cherry are similar to those of the other stone fruits. It has largely the same scale insects on the bark, the same buprestid in the trunk and black knot of the limbs, and the same insect and fungous diseases of the leaves and fruit, with the addition of the cherry fruit fly and the cherry leaf beetle and slug.

THE GRAPE.

The vineyardists must fight against the Phylloxera at the roots, the disease which at one time ruined the vineyards of France and Italy. There is also the root rot, the root borer and the root worm to contend with below ground. The vines are troubled with the cane borer, the cottony maple scale, the apricot scale, the tree cricket, anthracnose and mildew. The leaves suffer from mildew, blight, leaf hoppers, gartered plume moth, hawk moth, leaf roller, rose chafer, flea beetles, the anomala, and spotted pelidnota, and finally the fruit is attacked with black, ripe, bitter and white rots, downy mildew and anthracnose. The remedies for

these diseases are not always easy to apply, but are efficient and sufficient in the hands of the intelligent grape grower, while their very difficulty contributes to the profit of the business by keeping out of it over cautious and incompetent men.

These two special bulletins also discuss at length the diseases of the currant, raspberry, blackberry and strawberry and the insects which affect them.

This list of insect enemies and fungous diseases of our important fruits seems long and discouraging, but the bulletins hasten to say that there is one general means of defense against most of them. It is to spray early, thoroughly and often. The spraying materials are at hand in every village drug and grocery store, and methods of preparation and application are fully described in the bulletins themselves.

The Spraying Calendar simply tabulates, under the name of each fruit, the time to spray and what material to apply, giving also full directions as to the preparation of the spraying combinations.

For any station publication, apply, by postal card or otherwise, to the Secretary, Agricultural College, Mich., giving your own name and address. Agricultural College, Mich.

May, 1904.

BULLETIN 217

JULY, 1904



MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DIVISION OF CHEMISTRY

FERTILIZER BULLETIN

BY

FLOYD W. ROBISON

MAR 30 1905

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S. FRED EDWARDS, M. S.,	Asst. in Bacteriology	In charge South Haven Station.	
W. R. WRIGHT (student),	Asst. in Bacteriology		

SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
Chatham, Alger County, 160 acres deeded.

FERTILIZER ANALYSES.

FLOYD W. ROBISON.

Act No. 26 of the Session Laws of 1885 provides for the inspection and analysis of all brands of commercial fertilizers on sale in Michigan. In order to have these analyses serve the purpose best, it has been considered advisable to publish the results of analyses as early in the summer as the work will permit. These analyses cover goods shipped into the state in the spring of the current year and also in the fall of the previous year. The analyses are made upon goods selected in the open market in all cases when they may be found.

WHAT GOODS ARE SUBJECT TO LICENSE.

This division interprets as subject to license any fertilizers, so-called chemical sold as fertilizer, bone products, salts, ground rock, etc., the retail price of which exceeds \$10.00 per ton.

The manufacturer's license extends over a definite period of time and does not cover a definite brand of goods for all time. Because a certain brand of fertilizer is legally on sale during 1903 is no reason why it is legally on sale in 1904. As soon as the time limit of a fertilizer expires, that fertilizer is illegally on sale and is subject to all the provisions of the statute relating to unlawful goods. If dealers have such goods on hand they must either return them to the manufacturer or pay the license fee.

THE OBJECT OF A LICENSE AND ANALYSIS.

It is manifestly impossible by a simple, macroscopic examination of a fertilizer to tell anything about its value. Something may be told concerning the purity of food by a physical examination of the food, but the chemist himself can tell little of the value of a fertilizer except he analyze it in his laboratory. It is the recognition of this fact that caused the passage of the fertilizer law and placed it in the control of independent hands. To protect the user of fertilizers in a matter in which he is clearly and wholly incompetent to protect himself was the object of this law. Suppose a farmer decides to buy a fertilizer for his own use, the same fertilizer not being licensed, and as an inducement he is offered it at one or two dollars less per ton. The manufacturer gives him a guaranteed analysis, but he has nothing except the manufacturer's guaranty to assure him that the goods are what they are claimed to be. This station cannot analyze them for him for they are not licensed. He may be using a good fertilizer or he may be using one without value and he has no redress. On the other hand if the fertilizer in question is a licensed one the meaning is clear that the correct analysis of the goods is shown in the Annual Fertilizer Bulletin alongside the manufacturer's guaranty and the farmer knows that he can depend upon it. Neither the station analysis nor the fact that a fertilizer is licensed is proof

that the fertilizer is an especially good one. The object of the analysis is to reveal just what the goods are and just what they contain in fertilizing ingredients and the fact that they are licensed is simply evidence that they have been analyzed and their composition as compared with their claim can be ascertained by consulting the Bulletin. To render this work fully effectual farmers and granges who club together to secure reduced rates should insist before any such goods are bought that they bear the state license. This license requires an open, guaranteed statement of the composition and insures a chemical analysis of the Fertilizer.

LEGAL GOODS.

The fertilizers, the analyses of which are given in this Bulletin, are the only fertilizers that can be sold, lawfully, in this state. They may be sold from May 1, 1904, to May 1, 1905, and if a license is not issued for same on or before the latter date, then the goods must be withdrawn from the market. Dealers, as well as manufacturers, should co-operate with this division in securing evidence of goods unlawfully on sale. Any such evidence will be held in strict confidence and speedily investigated.

REGARDING SAMPLES.

Most of the samples analyzed were composite samples obtained by mixing in this laboratory fertilizers obtained from widely different sources. It is considered that the greatest possible fairness is secured by this method. In some instances the same brand has been twice analyzed and reported to show the variation to which the goods are subject. This has not been possible on all brands but only on those found in greater quantities.

The following is a partial list of persons and places visited during the past spring. Samples of fertilizers were taken from all or nearly all of these dealers and these samples, gathered in this way from the open market, are the samples the analyses of which appear in this bulletin. It was formerly a custom to print the name of the dealer opposite the analysis of the sample obtained from him, but so many samples of the same fertilizer are now obtained that such a procedure is no longer feasible.

Adrian—Nathan Smith & Son.

Albion—F. Steele.

Allegan—Schuler & Bourne, B. F. Foster.

Alma—Alma Sugar Co.

Bad Axe—William Rapson & Son, Cosgrove, Freeman & Co., B. A. & Grain Co., A. T. McDonald.

Battle Creek—I. H. Stiles, W. N. Dibble.

Bay City—Jenison Hardware Co., R. C. Bialy, Bay City Hardware Co., Ltd.

Benton Harbor—H. P. Boehn, B. N. Nowlen & Co.

Birmingham—E. R. Smith & Co., J. L. Truax.

Blissfield—M. Wolverton, A. G. Root.

Big Rapids—LaClair & Eggleston.

Capac—Wesley Nye, Colling & Co., Lang Bros.

Caro—M. H. Vaughan, Kelsey & Co., Caro Sugar Co., T. W. Vantyne.

Carsonville—C. J. Walker, A. H. Baird, Hartshorn & Anderson.

Carleton—Geiermann Bros., C. H. Reiser.

Clio—J. Wellman & Son, Fred Houghton.

Charlotte—Webster Cobb Co., Garber & Gibbe.
Coloma—Stratton & Blackman, Peck Bros.
Coral—N. B. Atwood & Co.
Clifford—Clifford Elevator Co.
Decatur—D. Trowbridge.
Denton—J. B. Schlicht.
Detroit—S. Baldwin.
Dowagiac—F. J. Reshore.
Durand—Hamlin Bros.
Eaton Rapids—C. D. Weisner.
Farmington—C. B. Pettibone.
Flint—Dane & Vermilya.
Grand Haven—James Locke, George Hancock & Sons.
Grand Rapids—Jones Seed Co., Brown Seed Co., Perkins, Hess & Thompson.
Greenville—M. Ludlow, Callahan & Ames.
Grosvenor—W. J. Rogers.
Hartford—E. D. Goodwin.
Hastings—R. K. Grant.
Holland—Keplar & Son.
Holly—McLaughlin Bros. Co., T. P. Morgan, M. N. Hudson.
Howard City—W. F. Nagle.
Hudson—Mr. Reed.
Ida—Silas Crane, Weiper & Cousino.
Imlay City—J. W. Green.
Ionia—Hubbell & Son.
Jackson—J. E. Bartlett Co., S. M. Isbell & Co.
Lansing—C. D. Woodbury, H. P. Gladden.
Lapeer—Robert King, Chase & Mitchell, Lapeer Mercantile Co., J. A. Porter, E. C. Roberts.
Ludington—Mr. Rasmussen.
Marlette—Kerby & Spring, W. I. Mathews, W. H. Wilson, Nelson Nichas.
Marshall—Hubbard & Beckwith.
Maybee—Leidle & Gramlich.
Milan—W. H. Hack, W. P. Lampkin.
Monroe—Gheckly & Martin.
Mt. Pleasant—Kennedy Bros.
Niles—S. E. Bolton, J. S. Tuttle.
Owosso—J. Brooks & Son, Parque & Graham.
Palmyra—J. E. Rouget, John Miller.
Petersburg—E. W. Spencer, C. J. Cilley.
Pigeon—Charles Schultz.
Pontiac—E. Holland & Sons.
Port Huron—M. D. Baldwin.
Royal Oak—Jacob Erb, J. M. Lawson.
Saginaw—Saginaw Beef Co., J. C. Derby.
Sebewaing—I. C. Liken & Co.
St. Clair—W. R. Kemps.
St. Johns—Byron Hanley, L. G. McKnight & Co.
St. Joseph—G. K. Pixley, E. Burton.
Temperance—A. H. King & Co., Sol Onsted.
Three Rivers—J. E. Griffiths Hardware Co.
Ubyly—Thomas Richardson, D. H. Pierce, Sparling, Pierce Elevator Co.
Vassar—F. Miller, L. M. Gage.

West Bay City—Mohr Hardware Co., George L. Mosher.

Wyandotte—Wyman Coal & Ice Co.

Ypsilanti—C. E. Thompson & Son.

Zeeland—Henry DeKriuf, Isaac Vandyke & Co.

BARNYARD MANURE AND COMMERCIAL FERTILIZERS.

There are few subjects which it seems can with propriety be discussed more frequently than the relative importance of barnyard manure and commercial fertilizers. There is abundant evidence to show that commercial fertilizers can never, on the American farm, entirely supersede the use of barnyard manure. Pound for pound most fertilizers contain very much more nitrogen, phosphoric acid and potash than does barnyard manure, but in most instances the growing test is in favor of the manure. There is unquestionably an influence physical, chemical or bacterial or all together that has a favorable effect on plant life and which can not be attributed solely to the nitrogen, phosphoric acid and potash present. Where all the products of the farm are fed on the premises and cared for properly there should be sufficient manure to keep the farm in a high state of fertility and on such a farm, in our opinion, the use of commercial fertilizers would be uneconomical. However, on small truck farms and on others where but little barnyard manure is available the use of commercial fertilizers is commendable. It is reasonable to suppose that no system of farming can be permanent that continually robs the soil of nutritive material without returning something to it. There is no question but that barnyard manure is the best source at the disposal of the farmer, to permanently increase the productivity of his land. No other fertilizer is so lasting in its effects. The great difficulty with a large number of Michigan farms is that it is impossible to obtain enough of this manure. On such farms commercial fertilizers have been used with a great deal of success and as the system of farming becomes more intensive the use of commercial fertilizers must likewise increase. All farmers cannot be dairymen and stockmen. Some must sell the wheat, fruits and garden products to support the rapidly increasing city populations, and such farmers must replenish in commercial fertilizers the equivalent, at least, of that which the exported crop removed. *The use of commercial fertilizers is not a fad and it will not down.* The man who has plenty of barnyard manure, however, will not buy fertilizers extensively, for they are clearly in a class below the natural manures, but the farmer who has not barnyard manure and cannot get it is compelled to use commercial fertilizers if he would keep pace with his neighbor in the productiveness of his land. On a still too large number of Michigan farms the great value of farm manures is not appreciated, neither is there exhibited great familiarity with the constituents and properties of these natural manures. The farmer who would use manures to the best advantage must become a student of the conditions causing the production of manures and the sources from which they are obtained. Comparatively few indeed are the farms where special effort is made to preserve the liquid manure from the stock fed and yet that is the most valuable portion of the animal excrement. The author is thoroughly familiar with countless examples of stables wherein the liquid excrement of animals instead of being saved in the manure, seeps through the cracks and holes in the floor and soaks into the ground beneath the barn, where, instead of being of value to the farmer, it becomes a constant menace to the health of the animals and the inhabitants of the near-by dwelling.

Some way of saving this material as well as the solid manure should be found and then in most cases let the manure be applied as fresh as possible to the land. It is quite generally conceded by practical men and scientists as well that the maximum effect is produced by the application of manures as soon as made. This is not always possible and yet it is usually found that the difficulty is apparent rather than real.

It does not seem to be a great task for some farmers to get into the habit of removing a wagon load of manure to the field as soon as it is ready and a habit of this nature, once formed, is productive of untold benefit. Let no farmer neglect the natural farm manures for the more easily handled commercial fertilizers but rather let the user of commercial fertilizers secure and use therewith as much barnyard manure as he can obtain.

LEGUMES, COTTON SEED MEAL, ETC.

It is quite generally conceded that a first rate method of reviving some lands is to plow under a crop of clover or some other legume as a green manure. It has been considered one of the best ways of applying a nitrogenous fertilizer to the soil, and it has the advantage over commercial fertilizers that ordinary barnyard manure has in that it is quite lasting in its effects. The benefit due to a leguminous crop is far beyond the actual composition of the plant for the effect of the decomposition is to materially change the climate and physical condition of the soil. On a farm well provided with barnyard manure, due to the feeding of much stock, it is doubtful if the benefits derived from the turning under of a leguminous crop are sufficient to counterbalance the value of the crop for feeding purposes. The application of the manure in large quantities would undoubtedly serve as well or at least nearly as well as the green manure, and at the same time the crop of clover will have contributed to the food of the stock. On farms or in orchards where no stock are kept and where the supply of barnyard manure is very limited the green manuring with a leguminous crop will be found a valuable contribution to the fertility of the soil.

In the southern states cotton seed meal is much used as a nitrogenous fertilizer, being applied directly to the land. It serves the purpose admirably and has an influence similar to that of barnyard manure and clover. Its great value for feeding purposes will prevent the use of this material on stock and dairy farms in Michigan for in this case as with clover, its value after feeding will be nearly as great as before and the intermediate product—milk or beef—will be an added source of wealth.

On small farms, gardens and orchards where no barnyard manure is available, cotton seed meal should prove a valuable manure. It contains a much higher content of nitrogen than do most commercial fertilizers and besides contributes much to the humus supply of the soil.

WOOD ASHES.

Much has been said regarding the value of unleached wood ashes—too much it would seem in some instances, for in many cases wood ashes have been used with quite detrimental effects. On some soils, not already light and sandy, wood ashes are valuable, for, besides supplying about 5% of water-soluble potash, the lime present in the ashes aids materially in producing a better physical condition of the soil. However, it is doubtful if in most cases ashes can be considered to have any commercial value above

that of the potash they contain. In general it may be said that wherever lime is desirable on a soil there ashes will also be beneficial.

CONCERNING FERTILIZER BUYING.

Fertilizers should be bought according to the needs of the soil and crop and not because they are cheap. A farm that is well nourished with barn-yard manure would not return the value of even the cheapest fertilizers. On the other hand on a farm which is in a run-down condition the dearest fertilizer available may be the cheapest in the end. Fertilizers are usually bought on the ton basis and yet that means little regarding their actual values. The bulletin gives the results of the analysis expressed in parts in a hundred. To get the parts in a ton it is only necessary to multiply these figures by 20 and the actual amounts of nitrogen, phosphoric acid and potash expressed in pounds in a ton will then be found. That a ton of one fertilizer can be bought for \$20.00 is by no means a reason that it is cheaper than another that sells for \$30.00. It is the analysis that tells and it is more frequently true that the fertilizer selling for the higher price is really the cheaper because it contains a correspondingly larger amount of the desired ingredients.

THE USE OF FILLER IN FERTILIZERS.

It is assuredly true that high grade goods containing little or no filler are much cheaper than low grade goods. A filler is used by the manufacturer to supply the farmers' demand for a cheap fertilizer. The filler may be dirt or any other substance not injurious to the soil. It costs the manufacturer a considerable amount to import the filler, mix it with the raw goods and transport it again to the farmer and it is of course the user who eventually stands all this expense. If the farmer will use high grade fertilizers or even the pure chemicals and salts themselves he will obtain his nitrogen, phosphoric acid and potash at a considerably reduced figure. By so doing he will not be paying the manufacturer for mixing and transporting a useless material as a filler and he will also save himself much labor in distributing the fertilizer on his land.

VALUATION OF FERTILIZERS.

The following prices may be used as representing quite closely the retail cost per pound of the ordinary forms of nitrogen, phosphoric acid and potash in chemicals and raw materials in our large markets. This cost does not include mixing nor transportation.

Nitrogen in nitrates	costs about 15c.	per lb.
Nitrogen in ammonia salts	" "	17½c. per lb.
Nitrogen in organic matter	" "	17c. per lb.
*Phosphoric acid (available)	" "	4c. per lb.
Phosphoric acid insoluble	" "	2½c. per lb.
Potash in the form of muriate	" "	4½c. per lb.
Potash in the form of sulphate	" "	5c. per lb.
Potash in the form of carbonate (ashes)	" "	5c. per lb.

*NOTE.—According to the present methods for the estimation of available phosphoric acid, considerable not strictly available is included. This is due to present imperfections of the methods for estimating phosphoric

HOW TO CALCULATE VALUES.

The value of a commercial fertilizer depends entirely on the values of the nitrogen, phosphoric acid and potash present. The following is an example:—

	Analysis. Per cent.	Valuation.	Total value.
Nitrogen	$= 7.77 \times 20 \times$	$.17 =$	\$16.22
Available phosphoric acid	$= 2.40 \times 20 \times$	$0.04 =$	1.92
Insoluble phosphoric acid	$= 2.10 \times 20 \times$	$.025 =$	1.05
Potash	$= 1.00 \times 20 \times$	$.05 =$	1.00
Total commercial value			$= \$20.19$

As may be seen above all that is necessary to obtain the commercial value is to multiply the amounts shown in the bulletin by 20 and then by the price per pound of that ingredient as recorded in the table of values.

ACKNOWLEDGMENT.

The analytical data recorded in this Bulletin have been much accelerated by the efficient assistance of Miss Dorothea Moxness, the assistant in chemistry. Mr. E. A. Boyer assisted also in the work of inspection and analysis.

acid. For example, in bone meals and phosphate slags varying amounts of phosphoric acid go into solution in the citrate reagent according to the temperature and degree of agitation of solution and also according to the degree of fineness of the fertilizer. These varying percentages appear in the analytical tables as available phosphoric acid. It is easily seen that a finely ground bone meal must furnish more real available phosphoric acid than one coarsely ground. In fact, it might be considered that with a bone meal ground to a flour nearly all of its phosphoric acid would be available. The Association of Official Agricultural Chemists through its referee on phosphoric acid, is investigating this matter and it is expected that a method will soon be formulated doing away with this imperfection. It seems probable that the value of these goods must be estimated on the total amount of phosphoric acid together with the degree of fineness.

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.	Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
				Available.	Insoluble.	Total.	
471	The Armour Fertilizer Works, Chicago..	Phosphate and Potash.....	Claimed..... Found.....	10 9.06	2 1.37	12 10.33	2 1.41
472	The Armour Fertilizer Works, Chicago..	Grain Grower.....	Claimed..... Found.....	8 8.50	2 2.64	10 11.14	2 2.26
473	The Armour Fertilizer Works, Chicago..	Bean Grower.....	Claimed..... Found.....	8 8.92	2 .94	10 9.86	2 2.45
474	The Armour Fertilizer Works, Chicago..	All Soluble.....	Claimed..... Found.....	8 8.30	2 2.25	10 11.55	4 4.99
482	The Armour Fertilizer Works, Chicago..	All Soluble.....	Claimed..... Found.....	8 11.06	2 1.75	10 12.81	4 4.26
481	The Armour Fertilizer Works, Chicago..	Bone, Blood and Potash.....	Claimed..... Found.....	8 9.81	2 1.35	10 11.16	7 6.69
520	The Armour Fertilizer Works, Chicago	Bone, Blood and Potash	Claimed..... Found.....	8 11.25	2 2.75	10 14	7 5.81
513	The Armour Fertilizer Works, Chicago..	Fruit and Root Crop Special.....	Claimed..... Found.....	8 9.16	2 2.15	10 11.31	5 6.91
523	The Armour Fertilizer Works, Chicago..	Sugar Beet Special.....	Claimed..... Found.....	8 10.17	2 1.33	10 11.50	4 2.86

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571	The Armour Fertilizer Works, Chicago..	Muriate of Potash.....	Claimed..... Found.....						48 49.14
567	The Armour Fertilizer Works, Chicago..	Steamed Bone Meal.....	Claimed..... Found.....	1.65 2.51	8	12	20 22.50		
581	The Armour Fertilizer Works, Chicago..	Wheat, Corn and Oats Special.....	Claimed..... Found.....	.82 1.01	7 9.85	2 .65	9 10.66	1 1.21	
583	The Armour Fertilizer Works, Chicago..	Bone Meal.....	Claimed..... Found.....	2.47 2.47	10	14	24 29.37		
588	The Armour Fertilizer Works, Chicago..	Ammoniated Bone with Potash.....	Claimed..... Found.....	2.47 2.47	6 7.32	2 2.05	8 9.37	2 2.17	
602	The Armour Fertilizer Works, Chicago..	High Grade Potato Fertilizer.....	Claimed..... Found.....	1.64 1.45	8 10.00	2 .72	10 11.62	10 10.72	
611	The Armour Fertilizer Works, Chicago..	Accidulated Bone Meal.....	Claimed..... Found.....	1.65 2.65	11 20.42	7 2.20	18 22.02		
612	The Armour Fertilizer Works, Chicago..	Star Phosphate.....	Claimed..... Found.....		14 16.12	2 0.60	16 16.02		
470	Tuscarora Fertilizer Co., Chicago.....	Steamed Bone Meal.....	Claimed..... Found.....	1.65 2.77			20 24.95		
585	Tuscarora Fertilizer Co., Chicago.....	Bone Phosphate.....	Claimed..... Found.....		10 12.70		12 12.95		
584	Tuscarora Fertilizer Co., Chicago.....	Michigan Special.....	Claimed..... Found.....	1.65 2.15	8 9.82	1 2	10 11.12	5 5.15	

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number. A	Manufacturer.	Trade name.	Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
				Available.	Insoluble.	Total.	
601	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Standard.....	Claimed... Found... 1.65 1.53	8 10.97	85	10 10.87	2 2.44
603	Tuscarora Fertilizer Co., Chicago.....	Ammoniated Phosphate.....	Claimed... Found... .82 1.	7 9.3	7	9 10	1 1.45
604	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Garden.....	Claimed... Found... 2.88 2.72	8 8.95	55	10 9.50	4 5.70
606	Tuscarora Fertilizer Co., Chicago.....	Wolverine Special.....	Claimed... Found... .82 1.11	8 11.1	4	10 11.5	4 4.31
607	Tuscarora Fertilizer Co., Chicago.....	Acid Phosphate.....	Claimed... Found...	14 16.27	35	16 16.63	.....
608	Tuscarora Fertilizer Co., Chicago.....	Bone and Potash.....	Claimed... Found...	10 11.65	35	12 13	2 2.13
609	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Trucker.....	Claimed... Found... 4.11 3.85	8 8.37	5	10 8.87	7 11.32
610	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Fruit and Potato.....	Claimed... Found... 1.65 1.73	8 10.77	45	10 11.35	10 11.18
618	Tuscarora Fertilizer Co., Chicago.....	Muriate of Potash.....	Claimed... Found...				48 49.

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619	Tuscarora Fertilizer Co., Chicago.....	Nitrate of Soda.....	Claimed Found.....	* 15.5 15.8					
489	Darling & Co., Chicago.....	Darling's Chicago Brand.....	Claimed Found.....	1.05 1.75	8 9.00	.....	.....	10 18.50	2 2.70
490	Darling & Co., Chicago.....	Farmers' Favorite.....	Claimed Found.....	2.47 2.68	8 9.00	.....	.....	10 15.10	4 5.05
504	Darling & Co., Chicago.....	Sure Winner.....	Claimed Found.....	.82 .86	8 9.81	.....	.....	10 11.56	3 3.45
536	Darling & Co., Chicago.....	Darling's Pure Ground Bone.....	Claimed Found.....	2.47 2.41	.....	.....	.....	23 27.13	.....
537	Darling & Co., Chicago.....	Darling's Western Brand.....	Claimed Found.....	.41 .56	7 8.40	.....	.....	9 10.06	.50 .65
548	Darling & Co., Chicago.....	Pure Bone and Potash.....	Claimed Found.....	2 14 2 15	.....	.....	.....	20 13 21.37	0 16 15
551	Darling & Co., Chicago.....	Sure Winner.....	Claimed Found.....	.82 .99	8 8.87	.....	.....	10 16.42	3 2.78
576	Darling & Co., Chicago.....	General Crop Brand.....	Claimed Found.....	.82 1	8 8.85	.....	.....	10 19.75	6 6.22
590	Darling & Co., Chicago.....	Acid Phosphate.....	Claimed Found.....	.....	10 18.25	.....	.....	14 25	.....
475	Swift & Co., Chicago.....	Bone and Potash.....	Claimed Found.....	2.50 1.96	.....	.....	.....	23 50 24.78	3 4.88

* Moisture=1.10 per cent.

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.		Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
					Available.	Insoluble.	Total.	
476	Swift & Co., Chicago.	Superphosphate.	Claimed Found.	1.64 1.58	8 8.53	 3.79	12 10.32	2 2.98
484	Swift & Co., Chicago.	Superphosphate.	Claimed Found.	1.64 1.58	8 7.84	 3.85	12 11.70	2 2
477	Swift & Co., Chicago.	Complete Fertilizer.	Claimed Found.	1 .75	8 7.79	 3.29	11 10.90	1 1.18
483	Swift & Co., Chicago.	Complete Fertilizer.	Claimed Found.	1 .98	8 8.15	 2.35	11 10.56	1 1.25
485	Swift & Co., Chicago.	Truck Grower.	Claimed Found.	.82 .81	8 8.37	 2.1	 10.47	4 3.76
499	Swift & Co., Chicago.	Truck Grower.	Claimed Found.	.82 .9	8 6.31	 2.75	 11.66	4 4.19
486	Swift & Co., Chicago.	Bone Meal.	Claimed Found.	2.50 2.38	.....	.....	25 26.42	.....
488	Swift & Co., Chicago.	Bone Meal.	Claimed Found.	2.50 2.18	.....	.....	25 27.16	.....
507	Swift & Co., Chicago.	Onion, Potato and Tobacco.	Claimed Found.	1.64 1.66	8 8.42	 3.8	11 12.02	7 6.32

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500	Swift & Co., Chicago.....	Onion, Potato and Tobacco.....	Claimed..... Found.....	1.64 2.64	8 8.35	 1.75	11 10	7 7.61
506	Swift & Co., Chicago.....	Swift's Lawn Fertilizer.....	Claimed..... Found.....	3.75 2.79	.....	.....	23 24.96	.....
516	Swift & Co., Chicago.....	Vegetable Grower.....	Claimed..... Found.....	3.25 2.50	9 7.31	 4	10 11.81	10 15.1
534	Swift & Co., Chicago.....	Sugar Beet Grower.....	Claimed..... Found.....	2.50 2.60	8 8.14	 1.55	11 19.09	5 6.41
570	Swift & Co., Chicago.....	Special Phosphate and Potash.....	Claimed..... Found.....	.....	10 10.93	 7	11 11.03	2 2.06
613	Swift & Co., Chicago.....	Bone Meal and Blood.....	Claimed..... Found.....	3.75 2.63	.....	.....	23 26.97	.....
502	The Jarecki Chemical Co., Sandusky, O.	No. 1 Fish Guano.....	Claimed..... Found.....	.86 .77	10 19.81	 2.9	11 19.91	1 1.20
508	The Jarecki Chemical Co., Sandusky, O.	No. 1 Fish Guano.....	Claimed..... Found.....	.86 .90	10 19.58	 2.55	11 15.13	1 1.06
530	The Jarecki Chemical Co., Sandusky, O.	Special Sugar Beet Grower.....	Claimed..... Found.....	.86 .65	8 9.30	 1.3	9 10.00	4 3.06
533	The Jarecki Chemical Co., Sandusky, O.	Special Sugar Beet Grower.....	Claimed..... Found.....	.86 .86	8 9.50	 4.7	9 13.36	4 3.73
538	The Jarecki Chemical Co., Sandusky, O.	Lake Erie Fish Guano.....	Claimed..... Found.....	.86 1.09	10 18.59	 3.55	11 14.44	2 2.44

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.	Claimed Found.....	Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
					Available.	Insoluble.	Total.	
547	The Jarecki Chemical Co., Sandusky, O.	Lake Erie Fish Guano.....	Claimed Found.....	.86 72	10 9.40	 3.1	11 11.50	2 2.87
582	The Jarecki Chemical Co., Sandusky, O.	C. O. D. Phosphate.....	Claimed Found.....	.....	14 15.25	 2.5	15 17.75	.....
591	The Jarecki Chemical Co., Sandusky, O.	Fish and Potash Potato and Tobacco Food.....	Claimed Found.....	.86 1.42	8 9.82	 1.3	9 11.12	4 4.73
596	The Jarecki Chemical Co., Sandusky, O.	Square Brand Phosphate and Potash.....	Claimed Found.....	.....	10 13.5	 1.7	11 15.2	2 1.57
620	The Jarecki Chemical Co., Sandusky, O.	Fish and Potash Grain Special.....	Claimed Found.....	1.2 1.40	9 11.6	 1.4	10 13.	2 2.87
480	Nathan Smith & Son, Adrian.....	Fertilene.....	Claimed Found.....	15 13.24	20 27.84	.....	20 27.84	25 25.9
568	Speidel & Swartz, Grand Haven.....	Celery Hustler.....	Claimed Found.....	7.75 6.33	3.40 5.85	 1.4	4.81 7.25	2.25 1.71
469	James Boland, Jackson.....	Blackman.....	Claimed Found.....	2.50 2.09	10 2.75	 11.	10 13.75	3 3.51
468	E. Burton, St. Joseph.....	Meat and Bone.....	Claimed Found.....	4.77 4.77	2.40 2.40	 2.10	4.50 4.50	

FERTILIZER ANALYSES.

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561	Grand Rapids Glue Co., Grand Rapids	Grand Rapids Fertilizer	Claimed Found	3 1.43	6 8.95	7.55	12 16.50	1 1.97
615	Kalamazoo Rendering and Fertilizer Co., Kalamazoo	Kazoo Brand	Claimed Found	5 4.18	1.5 0.02	4.85	8.5 12.87	
558	Canton Fertilizer and Chemical Co., Canton, O.	Peerless Corn, Wheat and Grass	Claimed Found	.86 2.16	7 10.68	1.19	8 11.87	1 3.43
493	Canton Fertilizer and Chemical Co., Canton, O.	Peerless Corn, Wheat and Grass	Claimed Found	.86 .91	7 8.95	0	8 9.85	1 1.25
535	Chicago Fertilizer Co., Chicago	Wheat and Corn Special	Claimed Found	.82 .76	7 7.47	2.95	10 43	1 .96
543	Chicago Fertilizer Co., Chicago	Potash Special	Claimed Found	.82 .64	8 9.74	3.45	13 19	4 3.34
545	Chicago Fertilizer Co., Chicago	Bone, Blood and Potash	Claimed Found	1.23 1.30	8 0.70	2.6	13 59	2 3.92
577	Chicago Fertilizer Co., Chicago	Potato, Truck and Tobacco Fertilizer	Claimed Found	*	*	*	*	*
521	The American Agricultural Chemical Co., New York	Bradley's Dissolved Bone with Potash	Claimed Found	1 1.21	8 8.45	2.30	10 10.75	2 1.92
549	The American Agricultural Chemical Co., New York	Bradley's Dissolved Bone with Potash	Claimed Found	1 1.04	8 9.44	1.15	10 10.59	2 1.58

* Unlicensed.

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.	Claimed. Found.	Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
					Available.	Insoluble.	Total.	
532	The American Agricultural Chemical Co., New York.	Bradley's B. D. Seafowl Guano.....	Claimed..... Found.....	2.06 1.88	8 8.61	 1.2	10 9.81	1.50 1.33
539	The American Agricultural Chemical Co., New York.	Bradley's Niagara Phosphate.....	Claimed..... Found.....	.82 1.37	7 7.67	 1.7	8 9.37	1 1
574	The American Agricultural Chemical Co., New York.	Bradley's Niagara Phosphate.....	Claimed..... Found.....	.82 .88	7 8.4	 2.1	8 10.5	1 .76
580	The American Agricultural Chemical Co., New York.	Bradley's Alkaline Bone and Potash ..	Claimed..... Found.....	.....	11 11.77	 2.85	12 14.12	2 2.83
584	The American Agricultural Chemical Co., New York.	Bradley's Soluble Dissolved Bone.....	Claimed..... Found.....	.....	14 14	 2.5	15 16.5	.....
491	The American Agricultural Chemical Co., New York.	Crocker's Dissolved Bone and Potash..	Claimed..... Found.....	.....	10 10.88	 1.60	 12.48	2 1.74
497	The American Agricultural Chemical Co., New York.	Crocker's New Rival Ammoniated Superphosphate.	Claimed..... Found.....	1.23 1.13	9 9.43	 2.95	 11.47	2 1.97
527	The American Agricultural Chemical Co., New York.	Crocker's New Rival Ammoniated Superphosphate.	Claimed..... Found.....	1.23 1.34	9 10.30	 1.6	 11.86	2 2.36
544	The American Agricultural Chemical Co., New York.	Crocker's General Crop Phosphate.....	Claimed..... Found.....	.82 .74	7 7.83	 1.8	 9.83	1 1.16

FERTILIZER ANALYSES.

570	The American Agricultural Chemical Co., New York.....	Crocker's Ammoniated Bone Super-phosphate.	Claimed Found.....	2.46 2.38	9 8.57	1.8	9.87	2 1.06
597	The American Agricultural Chemical Co., New York.	Crocker's Ammoniated Wheat and Corn Phosphate.	Claimed Found.....	2.05 1.96	8 9.95	.8	10.75	1.50 1.38
599	The American Agricultural Chemical Co., New York.	Crocker's Universal Grain Grower.....	Claimed Found.....	.82 .68	8 8.53	1.35	10.87	2 1.89
514	The American Agricultural Chemical Co., New York.	Niagara Wheat and Corn Producer....	Claimed Found.....	1.23 1.40	9 8.73	3.90	13.63	2 1.06
599	The American Agricultural Chemical Co., New York.	Niagara Dissolved Bone and Potash...	Claimed Found.....	.....	10 10.13	8.35	13.37	2 1.75
595	The American Agricultural Chemical Co., New York.	Niagara Potato and Vegetable Fertilizer.	Claimed Found.....	2.05 1.87	8 8.73	1.16	9.87	3 2.70
592	The American Agricultural Chemical Co., New York.	Niagara Grain and Grass Grower.....	Claimed Found.....	.82 .68	7 7.87	1.06	9.87	1 1.04
598	The American Agricultural Chemical Co., New York.	Fine Ground Bone.....	Claimed Found.....	2.47 2.13	.....	.....	22.8 30.87	.....
593	The American Agricultural Chemical Co., New York.	High Grade Garden and Vegetable Fertilizer.	Claimed Found.....	2 9.10	8 9.05	.05	10	6 9.30
492	Michigan Carbon Works, Detroit.....	Homestead, a Bone Black Fertilizer....	Claimed Found.....	2.06 2.63	8 9.55	.5	10.05	1.50 1.70
517	Michigan Carbon Works, Detroit.....	Homestead, a Bone Black Fertilizer....	Claimed Found.....	2.06 1.66	8 9.10	1	10.15	1.50 1.00

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.	Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K ₂ O.
				Available.	Insoluble.	Total.	
515	Michigan Carbon Works, Detroit	Homestead Odorless Bone Black	*	*	*	*	*
498	Michigan Carbon Works, Detroit	Homestead Potato and Tobacco Fertilizer.	2.06 2.34	8 8.8	1.6	10.4	3 2.98
550	Michigan Carbon Works, Detroit	Homestead Potato and Tobacco Fertilizer.	2.06 1.99	8 8.63	.56	9.13	3 1.89
500	Michigan Carbon Works, Detroit	Homestead Sugar Beet Fertilizer.	1.23 1.59	9 9.17	2.7	11.87	2 2.56
511	Michigan Carbon Works, Detroit	Homestead Sugar Beet Fertilizer.	1.23 1.33	9 8.57	3.95	11.63	2 1.53
496	Michigan Carbon Works, Detroit	Red Line Complete Manure.	.82 .84	7 8.99	2.1	11.09	1 1.53
503	Michigan Carbon Works, Detroit	Red Line Complete Manure.	.82 1.01	7 8.20	2.4	11.60	1 1.11
526	Michigan Carbon Works, Detroit	Red Line Phosphate.		14 15.98	.85	16.75	
536	Michigan Carbon Works, Detroit	Red Line Phosphate with Potash.		10 10.15	3.35	13.50	2 1.75

FERTILIZER ANALYSES.

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513	Michigan Carbon Works, Detroit.....	Banner Dissolved Bone.....	Claimed.. Found.....		30 35.81			
523	Michigan Carbon Works, Detroit.....	Dessicated Bone.....	Claimed.. Found.....	†1.23 1.86	.....	.....	25 24.56	.....
532	Michigan Carbon Works, Detroit.....	Wolverine Phosphate.....	Claimed.. Found.....	.....	10 8.55	1.46	10	.....
644	Michigan Carbon Works, Detroit.....	Pure Animal Bone and Potash.....	Claimed.. Found.....	.82 .47	.....	.....	22 29.13	10 8.16
529	Michigan Carbon Works, Detroit.....	Pure Animal Bone and Potash.....	Claimed.. Found.....	.82 .08	.....	.....	22 27.87	10 3.61
505	Northwestern Fertilizing Co., Chicago..	Garden City Superphosphate	Claimed.. Found.....	2.05 1.69	8 6.23	.....	10 9.13	1.50 1.32
519	Northwestern Fertilizing Co., Chicago...	Accidulated Bone and Potash.....	Claimed.. Found.....	.82 .35	10 11.89	1.66	12 13.44	1 .71
524	Northwestern Fertilizing Co., Chicago...	Horseshoe Brand Potato Grower.....	Claimed.. Found.....	2.46 2.19	9 7.77	.....	11 10.63	2 1.46
539	Northwestern Fertilizing Co., Chicago..	Horseshoe Brand Sugar Beet Fertilizer.	Claimed.. Found.....	1.23 1.24	9 10.07	.....	..... 13.13	2 1.97

* Unlicensed.
† Ammonia₂ = 1.50

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.	Nitrogen.	Phosphoric acid.			Potash soluble in water estimated as K ₂ O.
				Available.	Insoluble.	Total.	
546	Northwestern Fertilizing Co., Chicago	Horseshoe Brand Corn and Wheat Grower.	Claimed..... Found.....1.64 1.43	8. 9.14	 1.4	10 10.54	2 8.21
559	Northwestern Fertilizing Co., Chicago...	Quick acting Phosphate.....	Claimed..... Found.....	10 11.93	 7	12 12.93	.....
594	The Grange Fertilizer Co., Detroit....	Michigan Grange Wheat Fertilizer with Potash.	Claimed..... Found.....	10 9.87	 3.35	11 13.13	2 1.71
587	The Grange Fertilizer Co., Detroit.....	Michigan Grange Wheat Fertilizer.....	Claimed..... Found.....	14 13.59	 3.35	15 16.75	.....
593	The Grange Fertilizer Co., Detroit....	Michigan Grange, Corn, Oats and Grass	Claimed..... Found.....1.65 1.57	8 19.97	 1.30	9 11.37	2 3.15
600	The Grange Fertilizer Co., Detroit.....	Michigan Grange Complete Manure....	Claimed..... Found......82 .70	7 8.53	 1.35	8 9.87	1 1.04
606	The Grange Fertilizer Co., Detroit.....	Michigan Grange Potato and Vegetable Fertilizer.	Claimed..... Found......85 .60	8 0.5	 3	 11.5	4 3.87
510	The Ohio Farmers' Fertilizer Co., Columbus, O.	Ammoniated Bone and Potash.....	Claimed..... Found......82 .91	8 9.15	 3.55	 13.70	4 4.40
522	The Ohio Farmers' Fertilizer Co., Columbus, O.	General Crop Fish Guano.....	Claimed..... Found......82 .83	7 18.65	 1.85	 19.58	1 1.70

FERTILIZER ANALYSES.

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531	The Ohio Farmers' Fertilizer Co., Columbus, O.	Corn, Oats and Wheat Fish Guano.....	Claimed Found.....	1.23 1.48	8 8.41	 2.00	 11.31	2 2.30
541	The Ohio Farmers' Fertilizer Co., Columbus, O.	Corn, Oats and Wheat Fish Guano.....	Claimed Found.....	1.23 1.03	8 3.80	 2.45	 12.25	2 1.85
572	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Tobacco Food.....	Claimed Found.....	.82 .06	8 0.37	 1.50	9 10.87	4 4.12
575	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Grain and Grass Grower.....	Claimed Found.....	.82 .73	10 10.80	 2.45	11 12.25	1 1.33
580	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol High Grade Guano.....	Claimed Found.....	*	*	*	*	*
621	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Dissolved Bone and Potash.....	Claimed Found.....	.....	12 12.80	 1.05	13 15.75	3.00 3.08
622	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Wheat Grower.....	Claimed Found.....	.....	14.00 14.5	 2.00	15 10.5	.....
623	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Alkaline Bone.....	Claimed Found.....	.....	10 11	 3.00	11 14.06	2 2.10

* Unlicensed.



MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DEPARTMENT OF BACTERIOLOGY AND HYGIENE

SOME ESSENTIAL SOIL CHANGES PRODUCED BY
MICRO-ORGANISMS

BY

S. FRED EDWARDS.

AGRICULTURAL COLLEGE, MICHIGAN
1904.

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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.

Some Essential Soil Changes Produced by Micro-Organisms.

S. FRED EDWARDS.

INTRODUCTION.

The object of this bulletin is to review simply and briefly the present knowledge of soil bacteriology in its relation to agriculture with a view to emphasizing the close relationship between bacteriologic principles and the common operations of tilling the soil.

The problem of rendering his poor soil more productive, and his good soil still better, is one in which every farmer of today is interested. We venture the statement that of all the "run down" or abandoned farms in the United States there is not one which could not be made productive again if proper methods of handling the soil were employed.

The failure of land to yield a crop is not due in most cases to a lack of plant food in the soil. Results of chemical analyses show that in average soils throughout the country there is in the first eight inches, enough nitrogen to last 90 years, enough phosphoric acid to last 500 years, and enough potash to last 1,000 years. Why, then, if the soil contains such stores of plant food, does it fail to support crops? Simply because these elements are locked up in such chemical combinations that the plants are unable to utilize them.

The great problem, then, of modern agriculture, is not entirely the conservation of plant food in the soil, but rather the unlocking of the rich stores already in the soil, and placing them in a condition to be assimilated by plants. This unlocking process is carried on naturally by the soil micro-organisms.

Plants, from the mightiest forest tree to the tiniest blade of grass, consist of a complex combination of microscopic cells, each cell containing protoplasm. This protoplasm is continually changing, taking up food which is brought to it in the sap, and casting off its waste products in much the same manner as the protoplasm in the animal body.

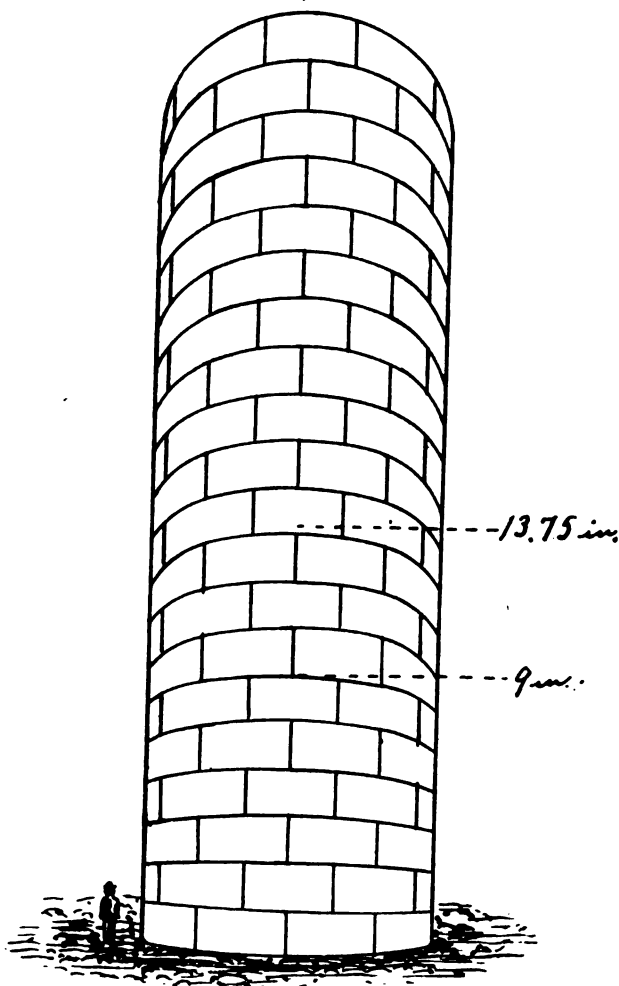
Bacteria are also plants, consisting, however, of but a single cell filled with protoplasm, which, like that of the higher plants, is continually active in assimilating from the surrounding medium the food elements necessary for its maintenance. These myriads of little plants, invisible to the naked eye, in taking their food from the chemical compounds of the soil, produce in those compounds just the changes necessary to render them useful to the higher plants in making their growth.

CONDITIONS OF GROWTH.

In order that bacterial activity may go on with undiminished vigor, there are certain conditions of the soil which must be provided, certain requirements of the bacteria which must be complied with, namely: temperature, moisture, reaction, respiration, and food supply.

TEMPERATURE.

Soil bacteria are most active at a temperature of 60° to 80° Fah., although some will grow at temperatures as low as 35° and as high as



CUT I.

The reservoir in Cut I is 100 feet high and 37.25 feet in diameter and will hold 3,400 tons of water. This is equivalent to 30 acre-inches of rainfall. 13.75 acre-inches, the average rainfall of our growing season, fills the reservoir to the point indicated.

Nine acre-inches, completely utilized, would produce a yield of:

30	bushels of wheat, or
57.45	bushels of oats, or
107.14	baskets of corn, or
42	bushels of barley, or
437.9	bushels of potatoes, or
2.03	tons of clover hay, or
4.33	tons of corn fodder, or
11.4	tons of ensilage

on the appearance and feel of dryness, although they may still contain a measurable amount of moisture, they have reached a point where they will no longer yield moisture to the growing crop.

CAPILLARY MOISTURE.

Capillary moisture is the visible moisture which clings to the walls of the soil grains or remains suspended in the smaller openings between the grains. Capillary moisture does not occupy all the pore space of a normal soil and therefore leaves room for the entrance of air into the soil. But there may be too much capillary moisture in a soil or too little for the best growing of crops.

THE IMPORTANCE OF SOIL MOISTURE.

The plant obtains all of its food, excepting carbon, from the soil or through it. In nature all these excepting a part of the nitrogen are derived from the soil materials, both mineral and organic, of which they form a part. These foods are dissolved in the soil water and the water with its dissolved materials is taken in through the roots of the plant and thence conveyed to the leaves where the food materials are reconstructed and much of the water thrown off into the air. From the leaves the remaining water with the reconstructed food moves out through the plant to the growing parts where the food is transformed into plant tissue or is stored for future use.

But the food materials in the soil before they can be dissolved by the water must undergo a change by which they are made soluble. Whatever this change may be, water is one of the agents by which it is produced.

Water then is important:

1. In the changing of plant foods into soluble form.
2. To dissolve and convey plant foods to and into the roots of the plant.
3. To convey plant foods from the roots to the leaves for elaboration.
4. To convey the elaborated foods from the leaves to other parts of the plant for use.

Nothing has been said of the importance of water in the germination of seeds. Without water the seeds would not swell to burst the coat, nor could the food stored in the seed be transformed, dissolved, and transported to the different parts of the young plant.

It requires large quantities of water to dissolve and convey the food to plants. To produce one pound of dry matter of crop requires the passage into the plant of from nearly 300 pounds to nearly 500 pounds of water. See Table II.

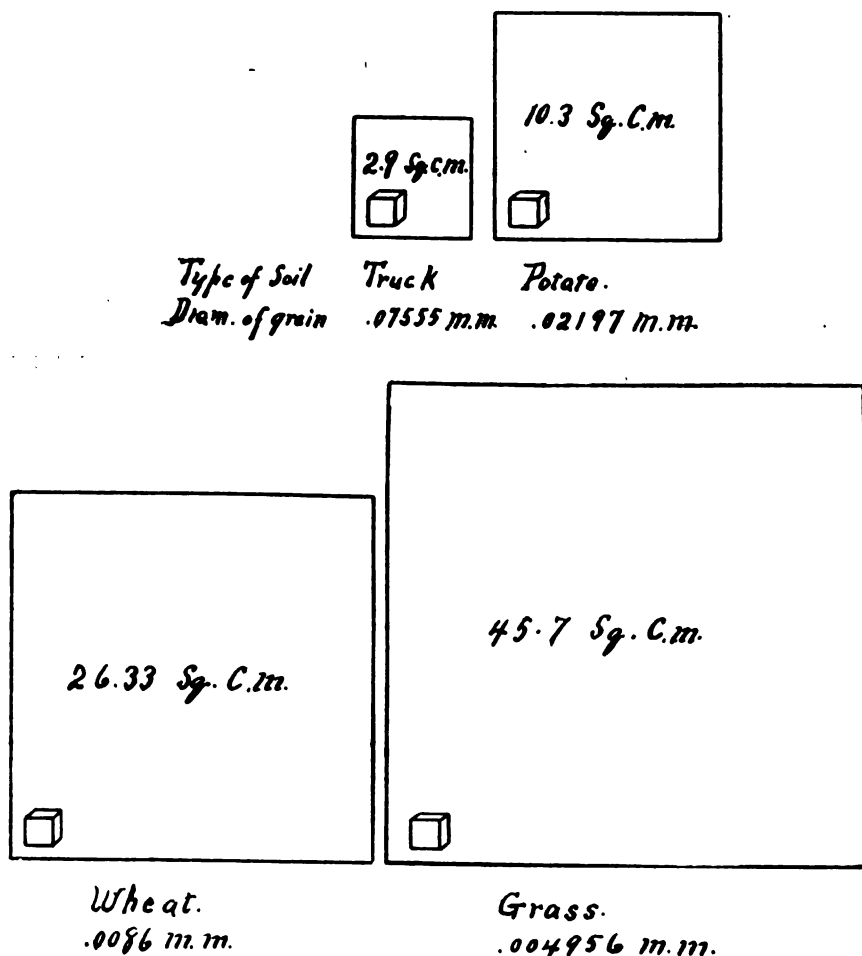
An inch of rain on an acre of ground (one acre-inch) weighs about 113.4 tons.

CONDITIONS INFLUENCING AMOUNT OF CAPILLARY WATER.

The amount of capillary water a soil will hold will depend upon:

1. The size of the mineral particles in the soil.
2. How these particles are combined into compound grains.
3. The amount of organic matter in the soil.
4. The degree of mellowness, or the tilth of the soil.

1. The finer the grains in a soil the greater is its water-holding power, other things being equal. This is true because the finer the particles of soil the larger the total surface the grains of a given weight of soil will present for the moisture to gather upon. For example, one pound of marbles one-half inch in diameter will present just twice as great total surface as one pound of marbles one inch in diameter, and theoretically



CUT II.

would hold twice as much water on their combined surfaces under the same conditions if not in contact. If in contact they would probably hold more than twice as much.

If the surfaces of all the grains in a cubic foot of some of our finer soils could be measured they would be found to amount to as much as four, five and sometimes more than five acres—five acres of surface to which water may cling, and all this in a single cubic foot of soil.

Cut II shows in a graphic way how the total surface varies with the

size of soil grain. The four squares represent the exact total surface of one-tenth of a gram, $=.0035$ of an ounce, respectively of a typical truck soil, a typical potato soil, a typical wheat soil, and a typical grass soil. The average diameter of the soil grain is indicated in each case. A millimeter (mm.) is about one twenty-fifth of an inch.

The small cube in each square represents closely the volume of one-tenth gram of the soil indicated.

The figures in the squares indicate the actual areas of the squares.

A cubic foot of the truck soil would have a total surface of about .3 acre, while a cubic foot of the grass soil would have about 4.12 acres.

2. What appear to be grains of soil in mellow loams and clays are usually not grains, but crumbs—composites consisting of tens, hundreds, and even thousands of individual or simple grains, held together partly by cementing materials in the soils and partly by water contained in the composites. Not only does the water help in developing this crumb-like condition, but a soil in this condition will hold naturally the largest possible amount of water for the use of crops, and at the same time will retain larger amounts from loss by percolation and evaporation.

3. The organic matter in a soil and especially the humus acts as a sponge would act. Its relative capacity for holding water is considerably greater than that of the mineral matter as you may have observed. Hence the importance of returning to our soils, especially to our loams, clays, and sandy soils, as much of the roughage of the farm as possible, and hence, also, the importance of following a careful rotation which shall result in part in an abundance of root material in the sub-soil.

Good applications of barnyard manure increase the water-holding power of soils.

Experiments in our laboratory show that when water is passed:

through 100 ozs. of an air dry clay soil,	56 ozs. were retained,
through 100 ozs. of an air dry loam soil,	49 ozs. were retained,
through 100 ozs. of an air dry sandy soil,	36 ozs. were retained,
through 100 ozs. of an air dry muck soil,	170 ozs. were retained.

In the first three cases the differences are due largely to the size of the soil grains. In the fourth case the great capacity of the soil for water is due to the large amount of organic matter present. The organic matter in this particular soil amounts to over 69%.

The presence of organic matter in a soil favors the development of the crumbly structure discussed above.

4. The importance of the manner in which the simple grains of soil are combined into composites, or crumbs, has been discussed under (2). The manner in which these composites are arranged in the soil mass—whether the soil is loose and open or whether hard and compact—is even more important.

If one takes the trouble to examine a productive virgin soil, he will find in it a natural mellowness, which still exists for a time after the soil is brought under cultivation. To this mellowness is due in no small degree the large crops which such a soil yields.

On the other hand a soil cropped continuously and carelessly handled for some time, is found to be lacking in this mellowness. It no longer produces good yields, and largely because it lacks mellowness, and

largely because in this condition it is unable to gather and retain the moisture needed for crop production.

In a mellow soil each crumb becomes a reservoir filled with food-laden moisture, and through the openings or archways separating these crumb masses from each other the roots of plants may readily travel, thus finding ready access to the moisture and food stored in the crumbs.

The really productive soils are those possessing the mellowness found in our virgin soils and they possess it because proper methods are employed in their tillage. These include a proper rotation of crops, the incorporating of an abundance of organic matter in the soil, and the wise use of tools.

Nature, left to herself, provides a crop, and usually a rotation, for the soil, in which:

1. The soil is filled with roots—often perennial roots which, with frost action, develop the crumbed and mellow or arched structure.

2. The bulk of the growth is returned to build up and enrich the soil. Bees may remove the nectares, birds may remove the seeds and grazing animals may crop off the grasses, but after all the roughage with much of the fertilizing material is returned to the soil. The wise farmer profits by the object lesson.

Nature, however, has need of no other tools than the roots and the frosts and the multitude of animal forms which burrow in the soil,—earth worms, ants, etc. The farmer must use the plow, harrow, roller and other tools. With the proper moisture conditions these tools may be made to help develop the mellow condition sought. Every farmer should learn to recognize this proper moisture condition and to appreciate its importance. If the soil be too wet the use of these tools may prove injurious rather than helpful. If a cultivated soil be allowed to become over dry, the drying often produces a degree of compacting that the use of these tools cannot overcome.*

RAINFALL.

The average annual rainfall for Michigan is about 30 inches. This equals 3,400 tons of water on every acre of land. See Cut I.

Our average rainfall during the growing months—April, May, June, July and August, for the fifteen years, 1888 to 1902, inclusive, was 13.75 inches and was distributed as shown by Table I.†

TABLE I.—*Showing the distribution of rainfall during the months of April, May, June, July, and August, 1888 to 1902.*

Section of State.	April	May.	June	July.	August.	Total for locality.
Upper peninsula	2.20	2.96	3.10	2.94	2.82	14.02
Lower Peninsula:						
Northern counties.....	2.04	2.91	2.95	2.75	2.72	13.37
Central counties.....	2.03	3.28	2.73	2.73	2.71	13.48
Southern counties.....	2.11	3.37	3.43	2.91	2.36	14.18
Average of sections.....	2.09	3.13	3.05	2.83	2.65	13.75

* See article "The Puddling of Soils," p. 85, Farmers' Institutes 1902-1903.

† This data was obtained through the courtesy of Mr. C. F. Schneider, in charge of the U. S. weather observing station at Grand Rapids.

CROP POSSIBILITIES IN THE RAINFALL OF OUR GROWING SEASON.

From tables given by Professor King in his *Physics of Agriculture* and in the Wisconsin Experiment Station literature, Table II is deduced for the purpose of indicating the size of crops possible if our rainfall could be completely utilized.

According to the table the average rainfall for the growing season if completely utilized for crop growing would produce much larger yields than are those now grown on the average farm of Michigan, but it is not utilized completely by our crops because:

TABLE II.—*Showing crop yields possible for different amounts of rainfall if completely utilized.*

Rainfall.	Bushels wheat per acre.	Bushels oats per acre.	Baskets corn per acre.	Bushels barley per acre.	Bushels potatoes per acre.	Tons of clover hay per acre.	Tons of ensilage per acre.	Tons of corn fod- der per acre.
4 inches...	13.5	25.53	47.62	18.69	194.1	.90	5.07	1.92
5 inches...	16.66	31.91	59.54	23.36	242.7	1.128	6.44	2.40
6 inches...	20.00	38.30	71.44	28.04	291.2	1.354	7.60	2.88
7 inches...	23.33	44.68	83.34	32.71	339.8	1.58	8.87	3.36
8 inches...	26.66	51.06	95.24	37.38	388.4	1.80	10.14	3.84
9 inches...	30.00	57.45	107.14	42.05	437.9	2.03	11.40	4.33
12 inches...	40.00	76.59	142.76	56.07	582.5	2.71	15.21	5.77

1. A portion is usually lost by surface drainage.
2. A portion sinks into the ground beyond the reach of the roots of the crops.
3. A portion rises again to the surface by capillarity, evaporates, and is carried away by the atmosphere.
4. The rainfall is often unevenly distributed.

If the soil were in proper condition, as set forth above:

- (a) The losses by surface drainage and by percolation would in many cases be entirely prevented, where they are now considerable, while,
- (b) In all cases the losses from all four sources would be materially lessened.

We have already spoken of the capacity of some soils for capillary water as determined in the laboratory. But these amounts would probably vary greatly under field conditions. Some data given by Professor King in his *Physics of Agriculture* indicate that after draining a few days after heavy rains the first five feet of a sandy loam might contain the equivalent of 10 inches of rainfall, a clay loam 15 inches and a muck soil probably considerably more than either.

It hardly needs to be said that not nearly all of this supply is available for crops. At the same time, even in rather sandy soils, intelligent tillage will accomplish some remarkable results with this store of soil moisture.

In 1897 the writer visited a field of rather coarse soil, which yielded 9.15 bushels of spring wheat per acre. The rainfall during the growing season was:

$\frac{1}{4}$ inch in May,
 $\frac{3}{4}$ inch in June,
 1-16 inch in July, and
 1-16 inch in August.

The rainfalls of July and August were hurtful rather than helpful.

THE IDEAL MOISTURE CONDITION.

When a soil contains about (usually a little more than) half the greatest capillary quantity it is capable of holding, it is in the best possible moisture condition for both the germination of seed and the growth of crops.

PRACTICE.

We have already indicated what may be done to give to the soil its maximum capacity for capillary water. But after this is accomplished certain methods of moisture management are necessary. These call largely for the intelligent use of farm tools. This is an art and a great art which every farmer should master.

TO DISPOSE OF EXCESSIVE MOISTURE.

1. As has already been stated, a soil may contain an excessive amount of capillary moisture and it is not always desirable or convenient to wait for its removal by natural means. The farm tool must be brought into use. It is presumed that the land is drained—best tile drained. If it is not and this excessive moisture is common, not many seasons should pass before it is drained.

(a) If the land has not been plowed, then the plow will probably be the tool used. If the soil be a clay or a clay loam:

1. Use a plow with a slanting mold board and do not plow deep; for the abrupt mold board and deep plowing will both have the effect of unduly packing the soil when over wet, which should be avoided.

2. After plowing, do not allow the soil to dry too long before it is gone over with a spike-tooth harrow or better, under some conditions, with a roller followed shortly by a spike-tooth. The object of the harrowing is to prevent the forming of hard lumps at the surface in the drying of the soil, as is almost sure to occur in the soils named if allowed to dry too long before a mellowing tool is used. It is easy enough to tell by feeling or even by the eye when this mellowing process should begin. It is not practiced as much as it should be.

The use of the roller as suggested will often improve the quality of the mellowing, but in any case will bring the newly plowed soil in more complete contact with that below which is a thing to be desired in spring plowing and will at the same time improve the capillary conditions of the newly plowed soil.

(b) If the soil has already been either fall or spring plowed, then the use of one of two tools may be suggested:

1. If the soil is loose the roller may be used. Its use will more thoroughly compact the soil grains, and moisture will rise more rapidly through a reasonably compacted soil than it will through a more open one. When a roller is so used, care should be taken not to allow the drying to go too far, for in such a case the surface may become over dry and even cloddy. At the proper time some stirring tool should be used. The use of the roller for this purpose should be exercised with much care.

2. The disc harrow may be used. The use of the disc will bring the more moist layers of soil to the surface and thus expose them to the action of the sun and wind.

There is less danger in using the disc than in using the roller, but even here intelligence needs to be exercised and the spike-tooth used at the proper time.

TO PREVENT MOISTURE LOSSES BY EVAPORATION.

A more important question with most farmers, though one not always appreciated, is how to prevent losses of moisture by evaporation. These losses are often greater than most of us realize.

Losses by evaporation, when the upper soil is well supplied with moisture, may amount to an inch of water in four days. In our laboratory, with little sunshine and no heavy drafts, moisture evaporates from an uncultivated surface 24 inches above standing water at the rate of one inch in 13 days. Reference to Table II will show what such a loss means to crop production.

Cultivation is the means usually employed to prevent evaporation losses.

The experiments conducted at the Wisconsin Experiment Station and described in their report for 1898, show how different the results of the same series of cultivations upon clay and muck soils.*

By cultivation is meant any stirring or loosening of the upper layer of the soil, and may be accomplished by means of the plow, harrow, weeder or cultivator.

Water cannot rise so rapidly through a loose soil as through a compact one.

Generally the deeper the stirring the more complete the saving of moisture. In a laboratory experiment in which the soil surfaces were 24 inches above standing water one cultivation 1 inch, 2 inches, 3 inches, and 4 inches deep respectively, resulted in savings over no cultivation, as shown in Table III.

In this case it is seen that the deeper the cultivation the greater the saving of water. This will be true for all soils probably.

TABLE III.—*Showing effectiveness of different depths of a single cultivation during a period of 21 days.*

Depth of cultivation.	Losses in tons per day.	Losses in inches.	Per cent moisture saved.
0 inches.....	10.4	1 inch in 10.89 days.....	0
1 inch.....	5.19	1 inch in 21.83 days.....	50.6
2 inches.....	3.36	1 inch in 33.72 days.....	67.7—
3 inches.....	3.16	1 inch in 35.85 days.....	69.6+
4 inches.....	2.86	1 inch in 39.61 days.....	72.5

It is generally believed that the more frequent the cultivations the greater the saving of moisture. Generally speaking this is true so far as studied for clays, loams, and possibly for sandy soils. It is not true for all soils. Soils rich in organic matter, such as the muck soils, profit by single cultivation, but so far as studied frequent cultivations do not promote the further saving of moisture.†

* See Michigan Farmers' Institute Report (p. 12), 1900-1901.

† See Michigan Farmers' Institute Report, 1900-1901, p. 12, and current report (1903-1904).

In practice it is found that, with cultivated crops on the soils indicated, frequent cultivations with cultivator, harrow or weeder, not over 2 inches deep prove most satisfactory.

It is found, too, in practice, that those who are most persistent in frequent shallow cultivating find it profitable practice.

HARROWING GRAIN.

The harrowing of grain crops is coming a good deal into favor. Going over the winter wheat field one or more times in spring with a spike-tooth harrow is found to give good results. Some farmers in the west practice harrowing their grains until they are so high as to be apparently considerably broken down by the harrow bars.

THE DRY EARTH MULCH.

A layer of dry soil is much more effective in preventing moisture evaporation than a layer of like depth of moist soil, and so it is sought by many, in practice, to develop by frequent cultivations a shallow dry earth mulch or "blanket," using the harrow, weeder, and later, the many-toothed cultivator.

USING THE ROLLER ON GRAIN.

The use of the roller upon a field of grain after the grain is well up gives excellent results in cases where the surface is lumpy and dry. The reason lies largely in the fact that in crushing the lumps a dry earth mulch is developed to lessen the evaporation while the packing of the soil may have the effect of improving capillarity below.

TO BRING MOISTURE NEARER THE SURFACE.

It sometimes happens that because of the looseness of the soil, water is not brought up sufficiently rapidly into the seed bed, or it may be that the evaporation from the surface is so rapid that the moisture from below cannot move upward rapidly enough to balance these evaporation losses. The result in either case is an insufficient amount of moisture in the upper soil.

1. A well developed mulch would reduce the evaporation losses, and since water moves more rapidly through moist soil than through dry, the tendency would be to accelerate the upward movement of moisture and in time to accumulate an abundance of it in the upper soil.

2. Rolling the land would compact the soil and thus increase the upward movement of moisture from below. The roller should be followed by some mellowing tool to develop a surface mulch and thus to lessen surface evaporation.

3. Had this soil received good dressings of manure, and the same been well incorporated in the soil, its presence would have had the effect both to gather moisture from below and to prevent its loss by evaporation.

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MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT

DRIED BEET PULP AND DRIED MOLASSES-BEET-PULP
FOR FATTENING SHEEP

BY

R. S. SHAW

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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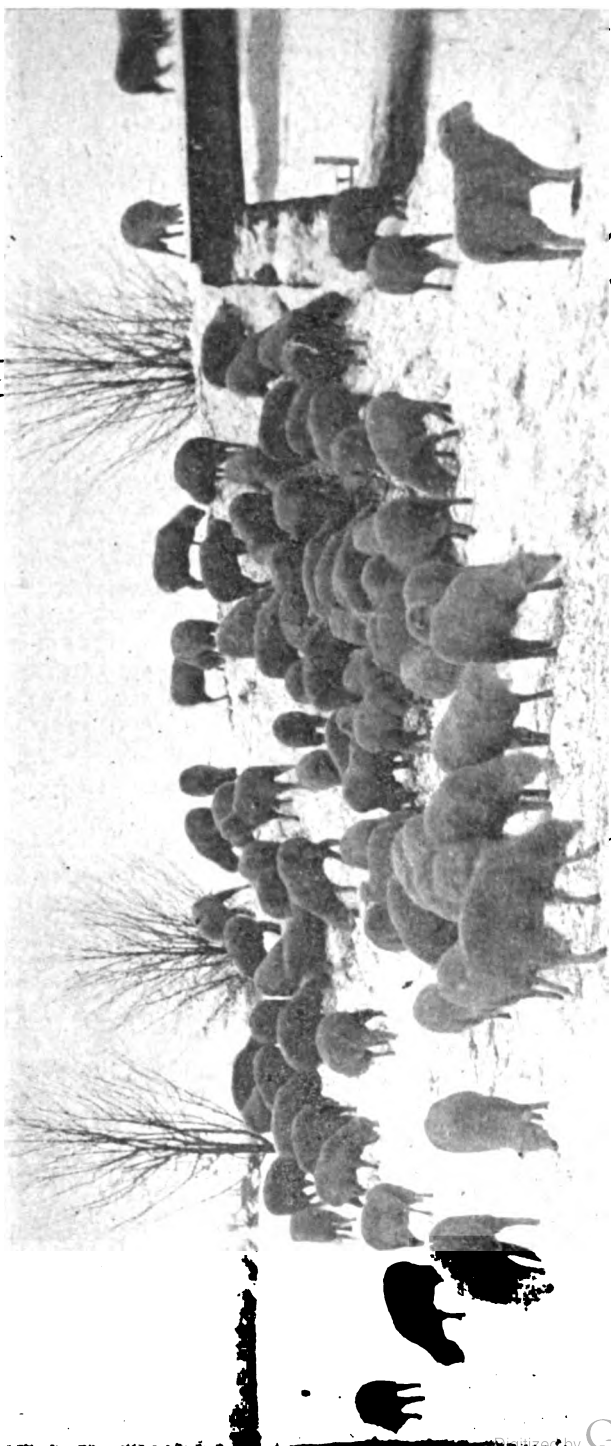
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THE LAMBS WHEN PURCHASED.

DRIED BEET PULP AND DRIED MOLASSES-BEET-PULP FOR FATTENING SHEEP.

BY R. S. SHAW.

Two years ago dried beet pulp was placed on sale in large quantities in various Michigan markets. One year later dried molasses-beet-pulp was also offered for sale to stock feeders. The wide distribution of these materials and the large quantities used have created a demand for information concerning their feeding value for various classes of animals. The objects of these experiments have therefore been as follows, viz.:

(1.) To determine the feeding value of dried beet pulp compared with corn.

(2.) To determine the feeding value of dried beet pulp when used in conjunction with grain rations.

(3.) To determine the relative feeding values of dried beet pulp and dried molasses-beet-pulp.

Two of a series of tests have been completed. In the 1902 and 1903 tests, dried beet pulp only was used; in the 1903 and 1904 tests, both kinds of pulp were used.

The following is a detailed description of the tests of 1903 and 1904.

THE ANIMALS USED.

On December 18th, 1903, ninety western lambs were purchased in Chicago, averaging 61.1 lbs., at a cost of \$4.60 per cwt. When delivered at the Michigan Agricultural College, on December 20th, these lambs averaged 58.8 lbs., having shrunk 2.3 lbs. in transit. On January 19th, 1904, when the experiment proper began, these lambs averaged 67.38 lbs.; at the close of the experiment, April 12th, eighty-five days later, they averaged 96.03 lbs. On April 16th, the lambs were shorn, producing an average of 6.56 lbs. of wool per head. On May 16th, at the time of shipment, the lambs averaged 99.88 lbs. During the time stated, no less than 47.6 lbs. per head was added to the 58.8 lb. lambs with which the feeding operations began.

METHODS OF FEEDING AND HANDLING.

The lambs were enclosed continually, there being no access to yards, each lot of eighteen being confined in a space 14x16 ft. Both grain and hay were supplied twice daily, the latter being fed in the same racks after the former had been consumed. Constant access to rock salt and water was provided, plenty of fresh air was supplied, and the proper temperature maintained as far as possible. From the beginning of the preliminary period, December 24th, 1903, the lambs were started on the rations used during the test proper. They were first given .25 lb. concentrates per head daily, which was gradually increased, a slight in-

cease being made each day. From January 19th to February 16th, the first twenty-eight days of the test proper, the lambs consumed an average of 1.01 lbs. concentrates per head per day; during the second twenty-eight days, from February 16th to March 15th, the amount reached 1.24 lbs., and during the last twenty-nine days, extending to April 13th, 1.60 lbs. We consider the gradual increase in the grain ration from day to day, and light feeding during the preliminary period, to be two of the most important factors in successful and economical sheep feeding.

Clover hay was supplied according to the needs of the lambs after consuming their various rations of concentrates. The weights hereafter given consist of the average of three consecutive days' weights, and date from the second weigh day.

Of the ninety lambs used in this test, not one was off feed for a single meal during the eighty-five days, nor could any ill-doers be found among them.

THE RATIONS.

The following are the rations used during the experiment, the proportions being given by weight:

- For Lot I. Corn 4 parts, bran 2, linseed meal 1; cost per cwt. 97c.
- For Lot II. Corn 4 parts, bran 2, linseed meal 1, beet pulp 7; cost per cwt. 77c.
- For Lot III. Dried beet pulp 4 parts, bran 2, linseed meal 1; cost per cwt. 78c.
- For Lot IV. Dried molasses-beet-pulp 3 parts, linseed meal 1; cost per cwt. 86c.
- For Lot V. Dried beet pulp 3 parts, linseed meal 1; cost per cwt. 78c.

The following food valuations represent the actual cost of the food-stuffs, nearly all of which, with the exception of the clover, were purchased in the open market: Linseed meal, \$28.00 per ton; bran, \$18.00; corn, \$18.00; dried molasses-beet-pulp, \$13.70; dried beet pulp, \$11.60, and clover hay, \$5.00.

THE PRELIMINARY FEEDING PERIOD.

During this period of twenty-six days from December 24th, 1903, to January 19th, 1904, the rations used for the five lots of lambs were the same as those heretofore described, and the following amounts were consumed by the various lots of eighteen each:

- Lot I. consumed 744 lbs. clover hay and 295.5 lbs. concentrates.
- Lot II. consumed 744 lbs. clover hay and 295.5 lbs. concentrates.
- Lot III. consumed 744 lbs. clover hay and 295.5 lbs. concentrates.
- Lot IV. consumed 698 lbs. clover hay and 295.5 lbs. concentrates.
- Lot V. consumed 730 lbs. clover hay and 295.5 lbs. concentrates.

During this period the consumption of concentrates was the same in every case, amounting to .63 lb. per head per day. Where, however, the two kinds of pulp were used in largest proportion for Lots IV and V, these lambs failed to consume as much hay as the others. The total cost of the food consumed during this period was \$21.42, and, considering

the large gain made, the cost of production was small. The fact, however, that the first weights were taken after a shrink, tended to increase the apparently normal gains.

Food consumed by the various lots during the 85-day experiment from January 19th to and including April 12th.

	Pounds.	Clover hay, pounds.	Cost.
Lot I. Concentrates (corn, bran, and linseed meal).....	1950.75	2353.00	\$24 82
Lot II. Concentrates (corn, bran, linseed meal and dried beet pulp).....	1950.75	2147.00	20 48
Lot III. Concentrates (dried beet pulp, bran and linseed meal)...	1950.75	2301.75	21 12
Lot IV. Concentrates (dried molasses beet pulp and linseed meal).....	1950.75	1987.00	21 80
Lot V. Concentrates (dried beet pulp and linseed meal).....	1950.75	2143.75	20 67

The amount of concentrates consumed in each case was exactly the same, averaging 1.27 lbs. per head daily, for the period. The variation in the actual amounts of roughage consumed is apparently due to the presence of pulp in the ration, less hay having been consumed where the most pulp was fed. The average daily consumption of hay per head ranged from 1.27 lbs. in Lot IV to 1.53 lbs. in Lot I.

The above figures represent the actual amount of clover hay consumed. After each feed, the racks were carefully cleaned and the refuse roughage collected and weighed at intervals. The waste, which consisted mostly of grain stubble and some woody stems, amounted to 6.38% of the entire roughage supplied. As the clover hay was of good quality, it was almost entirely consumed, much care being exercised in supplying about the proper amount at each feed. If the hay is coarse and of poor quality, too close feeding may become forced feeding and interfere with the gains.

Weights and increase in live weight during the 85-day test.

	Weight Jan. 19, 1904. Pounds.	Weight April 12, 1904. Pounds.	Gain. Pounds.	Cost per cwt. gain.
Lot I. 18 lambs.....	1189.3	1695.6	506.3	\$4 88
Lot II. 18 lambs.....	1226.0	1759.3	533.3	3 84
Lot III. 18 lambs.....	1218.0	1722.6	504.6	4 18
Lot IV. 18 lambs.....	1205.3	1730.3	525.0	4 15
Lot V. 18 lambs.....	1226.3	1735.3	509.0	4 06

Daily, weekly and monthly gains.

	Per day. Pounds.	Per week. Pounds.	Per month of 30 days. Pounds.
Lot I. Gain per head.....	.330	2.31	9.90
Lot II. Gain per head.....	.348	2.43	10.44
Lot III. Gain per head.....	.329	2.30	9.87
Lot IV. Gain per head.....	.343	2.40	10.29
Lot V. Gain per head.....	.332	2.32	9.96

CORN AND DRIED BEET PULP COMPARED.

The concentrates of the ration for Lot I consisted of corn 4 parts, bran 2 and linseed meal 1, while those for Lot III consisted of dried beet pulp 4 parts, bran 2, and linseed meal 1. Exactly the same amount of concentrates was consumed in both cases, but Lot I consumed 51.25 lbs. more clover hay than Lot III, a slight advantage in its favor as to total quantity of digestible nutrients consumed, but even this could not have made a difference of more than four or five pounds in the increase in live weight. As the total gain from Lot I was 506.3 lbs. and that from Lot III was 504.6, the former exceeded the latter by only 1.7 lbs. When we consider that thirty-six lambs were used in this part of the test, and that the feeding period continued eighty-five days, this small difference in gain in live weight cannot be considered. The only inference we can make in regard to the relative feeding values of dried beet pulp and corn, judging from the results of this one experiment with lambs, is that they are practically equal. As to the cost, one cwt. of increase in live weight from the corn ration cost \$4.88, while the same increase from the pulp ration cost but \$4.18, a difference of 70 cents in favor of the latter, but as the values of corn and pulp are subject to fluctuation, this is not a stable basis on which to fix a comparison.

GRAIN MIXTURES ALONE VERSUS GRAIN MIXTURES PLUS AN EQUAL AMOUNT OF DRIED BEET PULP BY WEIGHT.

The ration of Lot I consisted solely of grain and grain by-products, viz.: corn four parts, bran 2 and linseed meal 1, while the ration for Lot II consisted of corn 4 parts, bran 2, linseed meal 1, and dried beet pulp 7, or, in other words, equal parts of grain mixture and beet pulp. Precisely the same amounts of concentrates from these two rations were fed to the two lots of lambs during the experiment, but Lot I receiving the grain mixture, consumed 206 lbs. more clover hay than Lot II, one-half of whose ration consisted of beet pulp. As Lot I gained but 506.3 lbs. and Lot II 533.3 lbs., the latter produced 27 lbs. more mutton, and at a cost of \$1.04 per cwt. less than the lot receiving the grain ration without pulp. In fact, a perusal of the data given shows the lot of lambs receiving the grain and pulp mixture to have made not only the largest gains of the five lots, but to have produced these gains at the lowest cost. This is quite in accord with the popular belief that the sheep gives best returns from a variety of foodstuffs, and it is possible that the beet pulp may have acted as a stimulus to the vital functions of the animals.

Along this same line, the data from a preceding year shows similar results. During the winter of 1902 and 1903, two lots of wethers of fifteen each and also two lots of lambs of ten each were fed on a similar plan.

TEST WITH THE WETHERS.

Fifteen yearling wethers comprising Lot I were fed forty days on a grain ration consisting of corn 4 parts, bran 2 and linseed meal 1. Of this grain mixture they consumed on the average 2.48 lbs. per head per day, and 1.41 lbs. clover hay. The fifteen wethers of Lot II received a ration containing the same grain mixture, to which dried beet pulp

was added to the extent of eight-nineteenths of its weight. Of this combination they consumed 2.48 lbs. per head per day, and 1.41 lbs of clover hay. Lot I in the forty days gained 256 lbs. at a cost of \$7.87 per cwt., while Lot II, receiving the grain mixture containing pulp, gained 275.3 lbs. in the same time at a cost of \$6.35 per cwt.

TEST WITH THE LAMBS.

The two lots of lambs of ten each also fed in 1902 and 1903 consumed rations duplicating those just described for the wethers. The lambs of Lot I consumed 1.9 lbs. of the grain mixture without pulp and 1.42 lbs. of clover hay daily. Lot II, receiving the grain mixture with pulp added, consumed 1.9 lbs. of concentrates and 1.39 lbs. of clover hay daily. The first lot gained 160.3 lbs. during forty days at a cost of \$5.33 per cwt., while the second lot gained 140.6 lbs. during the same time at a cost of \$5.29 per cwt. In this one instance, the largest gain was made by the lot of lambs receiving the grain mixture without pulp, but the cost of production was less where pulp was used in the ration. In the 1902 and 1903 tests, the rations of concentrates were so exceedingly large that comparative results with striking differences were not expected. In these earlier tests the foods were valued at practically the same prices as in the later ones.

DRIED BEET PULP AND DRIED MOLASSES-BEET-PULP COMPARED.

Referring again to the data secured from the 1903 and 1904 experiments, we find that the eighteen lambs of Lot IV received a ration of concentrates consisting of dried molasses-beet-pulp 3 parts and linseed meal 1 part, while the ration of Lot V containing the same number of lambs consisted of dried beet pulp 3 parts and linseed meal 1 part. During the eighty-five day test, the lambs receiving dried molasses-beet-pulp gained 525 lbs. and those receiving dried beet pulp 509 lbs., an increase of 16 lbs. in favor of the former. The amounts of concentrates consumed were exactly the same, but the lambs receiving dried beet pulp consumed 156.75 lbs. more clover hay. The cost of gain per cwt. was \$4.15 where molasses-beet-pulp was used, and \$4.06 with the dried beet pulp. Though the former made slightly the larger increase in live weight in this instance, it was not sufficient to offset the additional cost of the molasses-beet-pulp. Observations concerning the relative palatability of these two foodstuffs have been made from time to time in which sheep seem to show a preference for the dried molasses-beet-pulp.

ANALYSES OF DRIED BEET PULP AND DRIED MOLASSES-BEET-PULP, WITH COMMENTS ON THE SAME BY MR. FLOYD W. ROBISON, EXPERIMENT STATION CHEMIST.

(The samples taken for analysis were secured by saving a small amount of pulp from that used each week during the experiment in mixing the rations. The composite sample therefore, contained material from twelve different lots.)

No. B 466, dried molasses-beet-pulp.

No. B 467, dried plain white beet pulp.

	No. B 466, per cent.	No. B 467, per cent.
Moisture.....	9.160	9.860
Ash.....	5.976	3.876
Protein (total).....	9.389	7.722
Proteids (true).....	6.845	7.547
Amids.....	2.544	0.175
Crude fiber.....	14.700	18.650
Fats.....	1.540	1.140
Carbohydrates.....	59.235	58.752
Sugars (total).....	23.000	10.580
Cane sugar.....	16.380	7.220
Dextrose.....	6.620	3.360
Fuel value in calories per gram.....	3802.44	3812.50

It will be noted that the molasses-beet-pulp carries a slightly lower percentage of water than does the plain white pulp. It should be a trifle more economical and desirous from this standpoint. It will again be noticed that the molasses pulp contains more total protein than does the plain pulp. This seems to be caused by the high percentage of amido bodies in the molasses, such an amount, in fact, as to make the per cent of true proteids in the molasses pulp considerably less than in the white pulp. It has been customary to consider the amido bodies to have practically no feeding value and from this standpoint the plain white pulp would of course be superior. It has seemed to me, however, that, inasmuch as many of the amido bodies make good culture media for bacteria, they might be considered as 'sparers' of true proteid in which case we should be compelled to give them a value in the ration. This value cannot, however, equal the value of a true proteid. From the standpoint of fiber, the molasses pulp is again somewhat superior to the plain pulp in that it contains a less amount of this material. It seemed quite reasonable to suppose that the higher the fiber content in a feed the less will be the net available energy of that feed."

"The other point in which the laboratory analysis shows a difference is in the amount of sugars present in the samples. It will be noted that the molasses pulp contains slightly more than twice as much total sugar as does the plain pulp. This should tend to increase the net available energy of the molasses pulp. It is doubtful if the presence of a greater per cent of sugar in the molasses pulp can be said to in any way increase the digestibility of that pulp. Whether the carbohydrate bodies are partially digested or not seems to make but little difference, if any, in the total per cent of digestible matter. It is certain, however, that the feed showing the higher content of soluble carbohydrates would furnish more available energy to the animal. It is surely certain that such a feed must be utilized at less cost to the animal system. On the whole the analysis seems to indicate a slightly higher value for the dried molasses-beet-pulp. It would be difficult to express this difference in actual money values, but the fact that all or nearly all of the differences are in reality but slight ones would not justify the giving of a very much greater value to molasses-beet-pulp."

SLAUGHTER TEST BY ARMOUR & CO.

Armour & Co., in submitting the figures, state: "The yield (dressed weight) is figured on the basis of 3% cooler shrink and the tallow is not considered in this weight, the figures given being net."

Result of test.

	Live weight. Pounds.	Dressed weight. Pounds.	Dressed. Per cent.	Tallow. Pounds.
Lot I.....	1560	818	52.43	117
Lot II.....	1600	835	52.18	165
Lot III.....	1550	803	51.81	132
Lot IV.....	1570	835	53.18	128
Lot V.....	1560	805	51.60	161

Only seventeen lambs from each lot were placed upon the market, one average individual from each pen being slaughtered at home in order to secure illustrations from the carcasses and cuts. These lambs sold on the market at \$6.10 per cwt., \$6.15 being the top price for the day. The day before shipment, the ninety lambs averaged 99.8 lbs. Eighty-five of these were sold on the market at 92.2 lbs. There was a large shrinkage, due, in part, to the twenty-four hours or more in transit. The ninety lambs netted a profit of \$106.65, or \$1.18 per head, after accounting for feed and every expense except cost of feeding, which is commonly offset by the value of the manure produced.

AMOUNT OF WOOL CLIPPED FROM THE VARIOUS LOTS ON APRIL 16, 1904.

The shearing was done by machine, by one individual, resulting in uniformity in the work done.

	Weight of wool. Pounds.	Average weight of fleece. Pounds.
Lot I. 18 lambs.....	109.5	6.08
Lot II. 18 lambs.....	115.0	6.38
Lot III. 18 lambs.....	121.5	6.75
Lot IV. 18 lambs.....	117.25	6.51
Lot V. 18 lambs.....	128.0	7.11

The concentrates of ration I contained no pulp, those of Lot II were one-half pulp, Lot III four-sevenths pulp, and Lots IV and V three-fourths pulp. With the exception of Lot IV, the production of wool increased with the increase in the amount of pulp consumed. There were, however, other variations in addition to the relative amounts of pulp consumed. Lot I contained corn 4 parts, bran 2 and linseed meal 1, while Lot II contained corn 4 parts, bran 2, linseed meal 1, and dried

beet pulp 7; the ration of Lot III, though consisting of four-sevenths pulp, contained no corn. The dried beet pulp of ration V contained more true protein than the dried molasses-beet-pulp of IV. Of course such influences as slight differences in breeding would tend to affect the wool production, but if these differences existed they could not be detected; the lambs were westerns and consequently were uniform. We have not produced these figures as proof of the fact that the beet pulp stimulated wool production, for our experiment does not prove that fact. These, however, are the results in this instance.

CONCLUSIONS.

1. These tests seem to indicate that both dried beet pulp and dried molasses-beet-pulp are possessed of feeding values comparing very favorably with corn.
2. That grain mixtures containing dried beet pulp produce more mutton at less cost than similar amounts of grain mixtures alone.
3. That dried molasses-beet-pulp possesses a somewhat higher feeding value than dried beet pulp, but in this experiment the difference was not great enough to offset the difference in price.

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NOVEMBER, 1904.

MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

POPULAR

THE CARE AND HANDLING OF MILK

PART I.

BY

CHARLES E. MARSHALL AND W. R. WRIGHT
(Department of Bacteriology and Hygiene)

PART II.

BY

JOHN MICHELS
INSTRUCTOR IN DAIRYING
(Department of Agriculture)

1905
The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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PART I.

MILK, ITS PURITY AND ITS IMPURITY.

(How to care for and handle milk.)

CHARLES E. MARSHALL AND W. R. WRIGHT.

I. THE SIGNIFICANCE OF PURE OR IMPURE MILK.

Successful dairy farming or successful milk production, as dairy progress becomes better defined, is more and more dependent upon ability, for, with constant and technical dairy development, dairying is fast growing into an exacting profession and those who attempt to play at it or simply to meddle with it will lose in the end. Farmer A may be able to produce good milk, while farmer B cannot; in the former instance, the man is qualified and understands the careful and correct production of milk; in the latter case, the man is not qualified, he is ignorant of the management of milk, and perhaps he is prejudiced in favor of, and determined to adhere to, old usages.

Good milk, good butter, and good cheese are acknowledged to be in great demand, and each brings good financial returns; the production of every quart of good milk and every pound of good butter or cheese is dependent largely upon the care and management of the milk, as well as the condition of the animal from which it is obtained. We shall commonly find that the difference existing between cheap milk and high-priced milk, cheap butter and high-priced butter, cheap cheese and high-priced cheese, lies in the difference in the care and management of the milk. Doubtless the production of good milk costs more than the production of poor milk; still there is generally more profit in the good milk than there is in poor milk.

It will be found, too, that where trouble exists between producer and consumer, between producer and butter-maker or cheese-maker, and even where trouble arises when the farmer tries to sell his butter to the grocer, that the contention is entirely founded upon the improper care of milk; for with good milk we shall find good consumers, with good milk we shall obtain good cream and good butter, with good milk it is possible to make good cheese.

(In Fig. 1, the authors have endeavored to illustrate by actual measurement the germ-content of different milks. Those familiar with estimating the number of germs in milk will appreciate the difficulty of securing numbers which are representative of all conditions and places, but will agree that the plate is approximately true.)

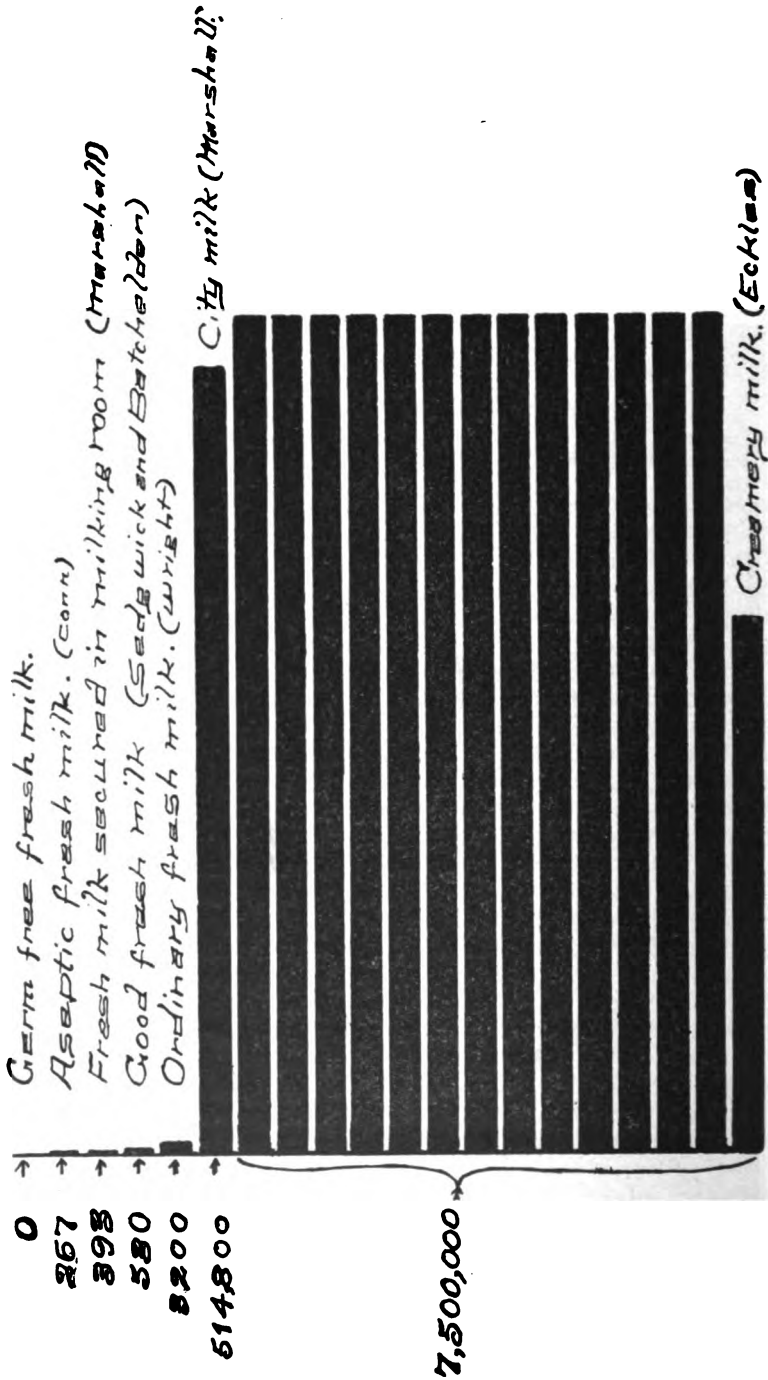


Fig. I.

If, on the other hand, milk is poor, the butter-maker or the cheese-maker will have to act the part of a physician who attempts to fight small-pox. He may be able to cure in some cases, but he will surely lose in others. If small-pox had been warded off, as it should have been, the physician would not have had trouble and a distasteful experience, and all would have gone well; in the same manner, if poor milk had been kept from the milk of the creamery or cheese factory, neither the butter-maker nor the cheese-maker would have had trouble in manufacturing good products. Consumers will not find fault if the milk is good. Poor milk may be eliminated and good milk substituted, but to do this it is necessary first that the individual be willing to make the effort, and second, that he must know how to direct his forces. It is our purpose to throw out a few practical suggestions. Do not understand that these suggestions must be followed exactly as stated in order to secure favorable results. The man who will be successful in obtaining profit will be able to take this bulletin as a whole, digest it, and utilize its contents under his own conditions. If he cannot do this, it is safe to say that he cannot produce good milk. The man who can pick out the principles and apply them in his own way, being able to cut out the *unnecessary* things and put into practice the *necessary*, will be the man who can produce good milk with little increase in expense over the production of poor milk.

In order to arrive at the full significance of milk, whether pure or impure, it will be desirable to enumerate certain subjects which might fall into the domain of pure milk production. These subjects are: the condition of the animal, whether sound or unsound; the condition of the stable, whether sanitary or unsanitary; the character of the water supply, whether good or poor; the nature of the feed, whether it is nutritious, whether it contains aromatic substances or whether it is unsuitable in any way. Then again, such things as the dust of the stable, the kind of stall, the individuality of the milker, the cleanliness of the pails, the straining of the milk, the aëration of the milk, the cooling of the milk and its further handling—all these matters will have to be taken into careful consideration and dealt with pertinently, rather than exhaustively.

II. TRANSMISSION OF DISEASE IN MILK.

Diphtheria, tuberculosis, scarlet fever, typhoid fever, cholera, choleraic disturbances, sore-throat epidemics have all been traced not infrequently to milk supplies. Those milking or taking care of the milk are generally at fault, for such individuals may be suffering from the disease or may be in communication with some one who has the disease; accordingly, a means of conveyance is provided. There is also the water supply or wash water which may be contaminated with sewage germs or the specific micro-organisms of typhoid fever, or those germs which may produce diarrhoea or sore throat.

The evidence in establishing the transmission of disease through milk is so abundant and so clearly defined that doubt cannot exist in any open mind.

(Fig. II illustrates cheese made from ordinary milk, really better than that usually furnished cheese factories. Note the gas holes produced by micro-organisms.)

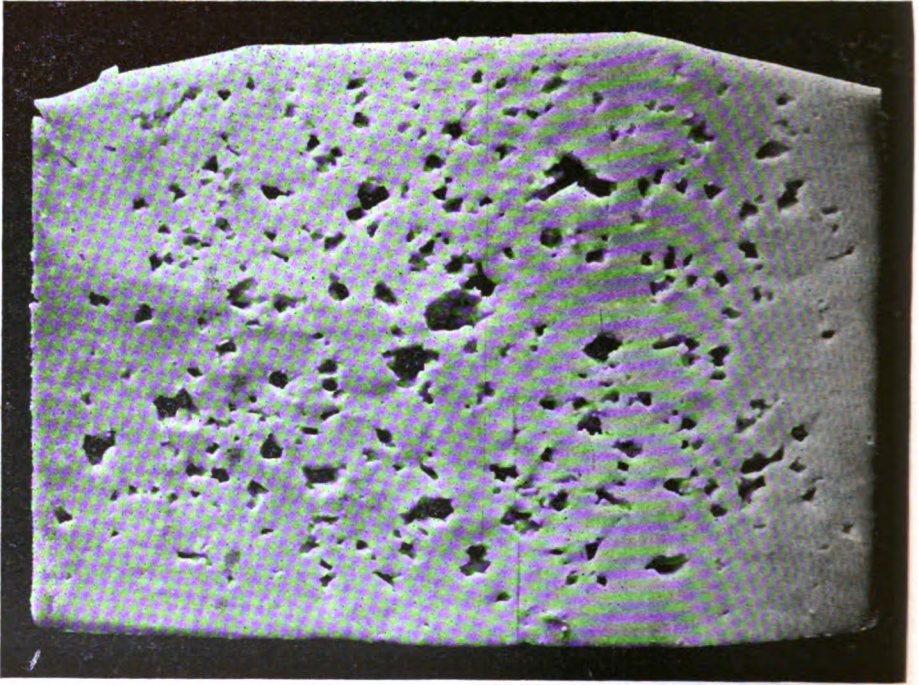


Fig. II.

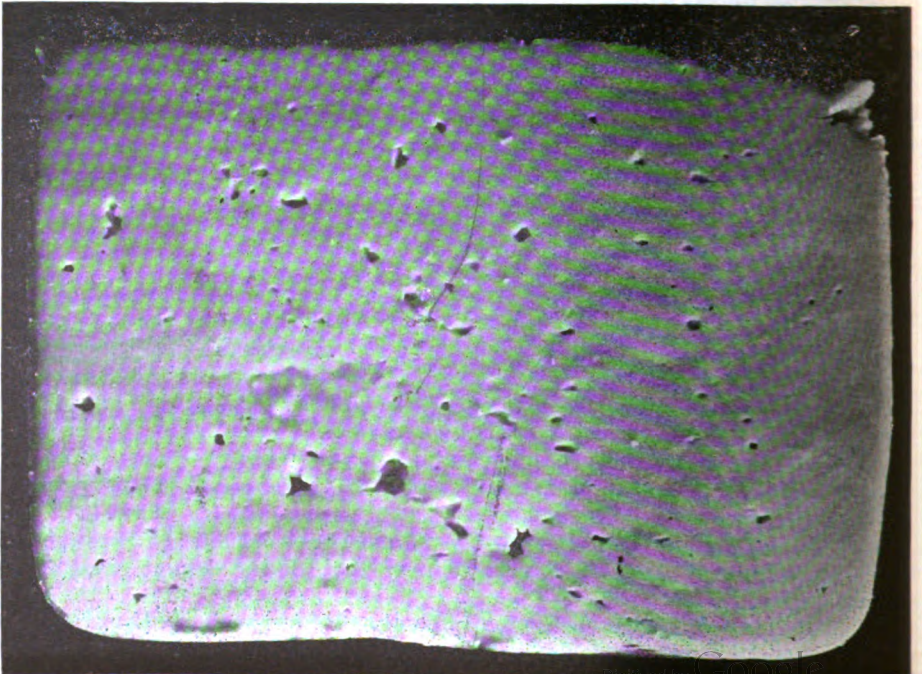


Fig. III

(Fig. III illustrates cheese made from good milk secured under practical conditions. Note the absence of gas holes.)

Our suggestion, therefore, relevant to this subject, is that those having communicable diseases, or in any way associated with others having any of these diseases, should neither milk nor handle milk which is consumed by the public. This is a common regulation for the control of public milk supplies.

III. THE INFLUENCE OF FEEDING UPON MILK PRODUCTION.

It is not in our province to discuss the economical methods of feeding milch cows. Rational methods of feeding are fairly understood, or access to such methods may be easily had, and what we have to say applies only to those feeds which may influence the character of the milk. We do find certain food substances which may influence the flavor and aroma of milk. Such substances are ensilage, turnips, rag-weed, leeks, chicory, rape, rye, cabbage, willows, fresh spring grass, potatoes and beet-pulp, and probably many others. It is true that ensilage, turnips, and other food substances may be fed to milch cows without causing any of these obnoxious results, and it is again true that they may be so fed as to produce them. Ensilage, for instance, is highly recommended for milch cows and it is doubtless one of the best foods that is known; consequently, feeding must be governed by one's experience, and he can soon learn that there are certain times when these aromatic foods may be taken into the stomach without causing any disturbance in the milk flavor. The quantity fed to each cow, or the time of feeding these foods have to do with milk conditions also. We call attention to these feeds because many times it will be found that some particular odor or flavor in milk may be traced directly to this source or even the character of the milk may be altered.

A certain milk company's regulations may serve to illustrate the significance of feeding for milk production. "All brewers' grain, refuse from distilleries and every kind of fodder which is not in a fresh or good condition is forbidden. Turnips and rutabagas are absolutely forbidden; no kind of turnip leaves is allowed. Vetches are forbidden. Rape-seed cake is the only oil-cake allowed. One and one-half pounds is the furthest limit, and along with it must be at least five pounds of corn and bran. Milch cows furnishing milk for infants must have no oil-cake."

From this it will be understood that attention should constantly be directed to the food given to milk-producing cows because such food may influence the aroma or flavor of the milk or may convey or cause to be conveyed to it substances which may make it unpalatable or even injurious to the drinker. The mother is usually familiar with the facility with which her food may cause disturbance in her nursing child. What is true of the mother is doubtless equally true of the cow. It is only necessary to recall the drastic poison in the cow's milk in milk-sickness or the possibility of poison secretion in milk when animals are bitten by poisonous snakes. While this subject may not be as definite as might be wished, yet there are sufficient facts to guide us in this matter of feeding.

Usually the feeding materials mentioned will not influence the milk seriously if fed two or more hours before milking or immediately after milking, and sometimes if fed in limited quantities.

IV. THE CONDITION OF THE ANIMAL, WHETHER SOUND OR UNSOUND.

Much is said, and many inquiries made concerning the production of milk from animals which may be afflicted with disease. This question is legitimate when the disease involves a race rather than individuals, but is not legitimate when it involves only individuals of a herd or individual herds. Tuberculosis is so rife among milch cows in some countries that it is practically impossible to eliminate all diseased animals without doing serious injury to the dairying industry of that country. Under these conditions it may be well to consider very carefully the best means of manipulating milk so that the disease will be curbed among the cattle, and at the same time will not endanger mankind. But when the disease is confined to a single cow of a herd or to a single herd of a community, then it appears that the most rational method would be simply to eliminate the sick animals from the milk-producing list.

Whether it is possible to establish an exact relationship between the disease in the bovine species and in man, is of little moment. It is fair to conjecture that no human being cares to run the risk or to even entertain the thought of drinking milk from a diseased animal. It may be in one case tuberculosis, where transmission through milk has been established, or it may be a case of lumpy jaw where transmission has not been established, or in some other diseased condition of the animal; but whether we know anything at all about the transmission of the disease to man, no matter how we view it, the thought of drinking milk from such diseased animals is obnoxious. No one should be obliged to drink milk from an unsound animal, and no one ought to be so inhuman as to think of it. The first assumption, therefore, is that in order to secure good milk the animal must be sound. It is a regulation of many cities of the United States that cows furnishing milk for the city supply must be sound and free from disease. The tuberculin test in many instances is recommended, but not enforced. The time will probably come when the milk producers will see the economical value of such a test and will voluntarily submit to its application.

V. THE CONDITION OF MILK IN THE UDDER.

For a long time it was supposed that milk in the udder of a cow was free from micro-organisms. This belief was founded upon the fact that some samples of milk drawn under methods which would eliminate contaminations from without, maintained their normal appearance for months. The results, of course, were not always uniform, but if the milk changed, it was supposed that these changes were wrought by accidental contamination. However, upon a closer study of this subject, it has been found that any milk in the udder of a cow contains a variable number of micro-organisms. Ward has made an extensive study of the bacterial content of milk in the udder. He finds several species and a variable number of micro-organisms. Conn, of Connecticut, in estimating the number in a series of tests, places the average number at 267 per cubic centimeter of milk in his so-called aseptic milk. Such milk is doubtless open to outside contamination to some extent. Others, working under similar conditions, have gotten results much the same. These germs which are found in the udder belong to different species, and the species are not constant, either

in number or kind. We may find germs which do alter milk, and those which do not alter it. Moreover, the number of germs present in milk as it is drawn, will not, as a rule, materially influence the changes in the milk, because it has been found, under practical conditions, that the germs which tend to alter or change the milk are those which enter from without, and the number of contaminating micro-organisms is, of course, in inverse proportion to the cleanliness practiced.

Usually, therefore, the germs which are present in the milk as it is drawn, may be considered in number as negligible, because those who produce pure milk have demonstrated that the keeping qualities of milk are not seriously interfered with by the germs present.

VI. THE CONTAMINATIONS OF MILK FROM WITHOUT.

1. Hairs.—Those who have studied micro-organisms found upon hairs of animals are well aware of the baneful influence they may have upon the changes in milk. A clean hair may have on its surface from fifty to two or three thousand micro-organisms; a dirty hair, almost any number above this. A dirty hair, therefore, entering the milk, may provide micro-organisms by the thousand or by the million. If the milk is strained, and the hair kept on the strainer, the micro-organisms go through just the same, and the surface of the hair is simply washed off. If, accordingly, a milker permits a dozen or two hairs to enter the pail during the course of milking, it means that probably millions of micro-organisms have been introduced into the milk.

Any one at all familiar with the stable is familiar with the character of the dirt on the surface of a hair. There are the micro-organisms which may cause trouble, and are usually capable of producing a variety of changes in milk. They may produce taints or fermentations of any kind.

In order, therefore, to eliminate micro-organisms from this source, it may be necessary to groom the cow thoroughly or to clip the hair on her udder. If the cow is kept clean, and is thoroughly groomed, the necessity for clipping is not so great. Further, by dampening the udder during the milking process, the hair may be made to adhere so that it will not fall into the milk.

2. Dirt.—The dirt that is usually found upon the cow, about the stall, or in the stable, or even on the milker, may contain as many as 80,000,000 germs per gram. About fifty per cent of the dirt that goes into the milk is soluble, the other is insoluble. This latter settles to the bottom. It has been estimated by Backhaus that the people of Berlin consume three hundred pounds of this filth in milk per day. This statement, of course, will assist the reader in understanding the amount of dirt that finds its way into the milk. Whether this dirt comes in the form of little particles of dust, or is adherent to straw, hair, hay or food—no matter how it enters, it is this kind of dirt and filth that contains the greatest number of obnoxious micro-organisms. Even in the seams of the milk pail it is possible to scrape out dried dirt and filth thoroughly loaded with these micro-organisms.

It therefore follows that in order to secure good wholesome milk, we must provide some means of keeping this dirt out. This can be done by means of clean clothes and clean hands for the milker, clean dairy

utensils, careful manipulation of the pail and the selection of a clean place to milk; in short, by removing the cow and the milker from an uncleanly environment, the dirty stable, into the open air or a dustless room.

At the present stage of development, many of these maneuvers may be looked upon as impracticable and employed only by those having a single cow in the city; yet these methods have been practiced by actual milk producers, who have aimed at high standards. All that can be said in regard to the practicability of such methods is, if it can be done, the value of the milk will be enhanced; if it cannot be done, have the stable as free from dust as possible, make no disturbance by bedding and feeding previous to milking, exercise as much caution as consistent, and even under these conditions one will be surprised at the results he can obtain from a little effort. Dirt can be eliminated in a degree even in the filthiest places. It rests with the milk producer to determine how far he can go in this matter, and his ability to introduce these desirable methods will depend upon his ingenuity and his sales.

3. The Stall.—It is not pertinent or necessary to discuss the different kinds of stalls in this connection. It is patent that the less surface exposed in the stall, the better the stall is for milking purposes. Therefore, a half partition stanchion stall is frequently selected by dairymen because it enables them to handle themselves while milking. There are some closed stalls having iron piping for the partition walls, which, of course, is expensive, but reduces the amount of exposed surface. If one has to milk in the stall, he needs a roomy place and it is quite desirable that the milker should not rub up against other cows, or the cow which he milks, or against the surface of the stall, or, in short, come in contact with anything that tends to create a disturbance in the atmosphere or stir up the dust.

The plan to follow, therefore, is to select a stall which has as little surface as is required for the separation of the animals, have the stall roomy and make it as convenient for the milker as possible. Again, if the cow can be removed from the stall, undoubtedly the best results will be obtained. Mr. Michels will illustrate some stalls found by experience the most satisfactory in the production of milk.

4. The Milker.—It is not possible to place too much stress upon the condition of the milker, for through his individuality may be found the answer for or against the production of pure and wholesome milk. If he is an individual who is naturally clean and tidy, the milk will accordingly be as good as can be produced under the conditions furnished; but if he is untidy and by nature filthy, the milk likewise will be found very dirty. The cleanliness of clothes and hands is a matter which the farmer occasionally abhors. He finds it sometimes troublesome to don a clean suit of clothes and wash his hands for the purpose of milking a few cows which supply his own table. Perhaps where so few cows are involved, the custom could be regarded as impracticable, especially if the aesthetic feeling is at a low ebb; but where dairying is looked upon as a business, and the milk and its products are sold to the public, considerations of cleanliness and care in the handling of milk cannot be despised or overlooked.

Dirt will manifest itself, and it is easily washed off from the hands

into the milk by an occasional stream of milk impinging against their surface; or, it may fall from the clothes in a dry condition or be brushed off in one way or another and thus contaminate the milk. The hands of the man who works about the stable and fields are not, as a rule, fit to handle food, and he would not be expected to go into the kitchen and prepare a meal without washing his hands, nor could he be expected to come in close contact with food without changing his clothes, or, at least, donning an over-suit. If this is true, why should he be expected to milk cows and handle milk without being as cleanly as if he were preparing some appetizing food in the kitchen? Clean hands, clean clothes and clean habits are as essential to the production of good milk as they are to the housekeeper who prepares our meals; or as they are to society considered from an aesthetic standpoint.

There is another aspect of the milker which deserves careful review. He should be a sound man, free from any infectious disease, because it is an easy matter for a milker to transmit the germs from himself to the milk by means of his hands or his clothes or in various ways. Imagine a man suffering in the last stages of consumption handling the milk for sound individuals or that which is to be used for babes! Do what he will, he cannot free himself from contamination with those germs which, if they once find their way into the milk, are capable of setting up disease. What is true of tuberculosis is also true of diphtheria, scarlet fever, and other diseases. These are facts, fully established, and the significance of which is well known.

Again, the milker should never come in contact with any one suffering from an infectious disease, for he may be the means of conveying the germs and thus cause a communicable disease to spread. Such instances are known, and it is easily understood how this may be the case. We conclude, therefore, that in order to have good, pure, wholesome milk, it is essential that the hands be washed; that a clean outer suit of denim, duck, or something similar, be donned; that freedom from disease exist, and that there be no communication with infectious diseases of any kind. The milker must observe these strictures upon his freedom, and should enter into their execution with zest if good results are to be obtained.

5. Milking Utensils.—Perhaps one of the most common sources of trouble, although it is not usually admitted, is the polluted condition of the utensils which are employed in the care of milk. Even in this civilized country, with its accumulation of knowledge, there are many milk producers who do not yet appreciate the fact that in order to have good milk it is essential to have clean utensils. From 500,000 to 50,000,000 of germs have been counted in each gram of dirt taken from the creases in a milk pail; while from its surface have been taken many thousands per square inch. This should never occur in a clean pail and one that is carefully cared for. Pure milk is impossible under such conditions.

It is not sufficient to wash out or rinse out a milk pail or any other milk utensil with warm or cold water and a cloth only; a brush is necessary, and it should be used with zeal and with a goodly amount of warm water at first; then it should be followed by a wash with a solution of sal-soda or lime water, or something akin, for the purpose of removing the fat. After this is done the utensil should be thoroughly

rinsed with boiling water, then steamed, which will have a tendency to kill all micro-organisms present. Such treatment is the least to be done in cleaning milk utensils. If the milk producer does not believe in the thorough cleansing and its effectiveness, let him add milk from a sample lot, half of it to a dirty pail, and half of it to a properly cleansed pail, and watch the results. He will convince himself by this simple act.

A word might be said about the scientific significance of the sanitary milk pail so commonly mentioned at the present time. It is true that, if filthy conditions exist in the stable, also with the cow and milker, an open pail makes it possible to collect much dirt and filth; and that, if the opening were reduced in size, a certain amount of this filth would be eliminated. On the other hand, if the stable is clean and free from dust, the cow properly kept, the milker clean and tidy, and the pail sterile, the ordinary pail will give nearly as good practical results as the sanitary pail. If filthy conditions exist, it were better to milk through a pin-hole; but if proper conditions are established, one need not spend his energy in trying to strike the hole of the pail. Thus far, sanitary milk pails are not especially successful. This is true also of automatic milkers. Such things cannot overcome the real cause of the disorder. Usually these attempts amount to about the same as trying to cleanse the body by putting on a clean garment. The appearance may be a little better, but the results are not very satisfactory. If the pail is left open in a stable filled with dust, Marshall has estimated that as many as 3,600,000 germs may fall into that pail during the course of five minutes. In an ordinary room, free from dust, the number of germs would be comparatively insignificant.

6. Water Supply.—Water is a source of contamination too frequently overlooked. Some years ago an opportunity was offered for analyzing several samples of water, coming from dairies, creameries, and cheese factories. It was found that some of the samples furnished were veritable starters of an obnoxious character, such, in fact, as would produce bad results in milk and butter or cheese manufacture. Doubtless, therefore, if it were feasible to go through the country and ascertain the exact condition of the water supplies, the analyses would be more or less startling.

Typhoid fever epidemics have been traced to water employed in the washing and rinsing of dairy utensils. Other infections also have had such water supplies for their source. Besides the direful effects of water in the conveyance of disease, there are the numerous serious fermentations which may be caused by the micro-organisms in the water supply. Traces of sewage, filth, or dirt, may be in the water, consequently the water may be as undesirable as the substances found in it.

VII. AERATION OF MILK.

The discussion concerning the aëration of milk is becoming a thing of the past. Practices are becoming quite uniform. Our readers are more or less familiar with the work of Special Bulletin No. 16, of this Station. We mean to quote a few paragraphs which will place before the reader some of the essential points concerning this phase of milk management.

"If agitation of milk therefore aids aëration and if during the few moments immediately after milking the interchange of gases between the air and milk is greatest, it follows that where milking is in process the air must be pure, otherwise the foulness of the air will be incorporated in the milk. Milk absorbs gases. What must be the condition of the air of a stable in which all sorts of fermentations are going on and in which are odors of diverse kinds? These obnoxious substances are in the air and must pass into the milk with the air.

"In addition to milking, frequently the milk is further agitated in the stable by passing it from pail to pail or even straining it and also sometimes aërating it. Such methods are rightly condemned and the reasons for such condemnation are conclusive. Milking and the handling of milk should be carried on in pure air. It is sometimes the practice of milk producers to pour milk directly from the milking pail into a ten gallon can. From the foregoing even this must be considered reprehensible, for filling the can excludes the oxygen, and, if the milk is not cooled, a temperature most suitable for the development of germ life is present—conditions, in short, which favor harmful fermentations. This is why there are recorded so many cases of poisoning as due to the improper care of the milk, eliminating the factor filth, a common evil.

"It has long been known that animal odors and taints may be removed by aëration. Proper aëration will do it; however, aëration and cooling must not be confounded in this matter. Cooling apparently removes odors and taints, but such disappearances are due to the chilling of the milk, under which condition the milk gives up the volatile substances with reluctance, doubtless owing to the reduced power of volatility of the substances themselves when cold. When such odors and taints are removed by aëration the removal is permanent unless they are generated by bacteria which continue to grow after aëration. Odors and taints may be due to any one of the following causes:

1. Absorption of gases from the air by the milk.
2. Physiological processes of the cow.
3. Disease processes of the cow.
4. Bacterial growth in the milk.
5. Introduction of odoriferous substances into the milk.

"Odors in the air emanate from fermentations, foods, etc.; aromatic substances are likely to pass through the body and be secreted in the milk; a high temperature in an animal is likely to reveal itself in the milk; and frequently sufficient filth gets into the milk to give it a distinct flavor—all of these or any one of these causes may be the immediate producer of odor or taint.

"How aëration should be conducted is a matter of considerable importance, consequently we have added a few suggestions:

1. Aëration should be conducted at body temperature.
2. Aëration should be carried out over the most extensive surface possible and as slowly as possible.
3. Aëration should take place only in a pure atmosphere.
4. Aëration is best accomplished immediately after milking.
5. Aëration should precede cooling.
6. Aëration and cooling simultaneously conducted cannot yield the most satisfactory results."

VIII. THE COOLING AND THE KEEPING COOL OF MILK.

No one factor will contribute so much to the welfare of the milk producer as a knowledge of cooling milk and its real significance, for in this process we have the key to the management of either good or bad milk. Good milk will remain good indefinitely if kept sufficiently cold and bad milk will not grow worse if kept under the same conditions. Conn has done the most recent and most exhaustive work along this line. His table in Bulletin No. 26, of the Connecticut Experiment Station illustrates this very graphically.

Number of bacteria per c. cm. in milk kept at different temperatures.

Number at outset.	In 12 hrs. at 50°.	In 12 hrs. at 70°.	In 50 hrs. at 50°.	In 50 hrs. or at time of curdling at 70°.	No. hrs. to curdling at 50°.	No. hrs. to curdling at 70°.
46,000	39,000	249,500	1,500,000	542,000,000	190	56
47,000	44,800	360,000	127,500	792,000,000, 36 hrs.	289	36
50,000]	35,000	800,000	160,000	2,560,000,000, 42 hrs.	172	42

It is easily seen from the above how important it is that the milk be cooled, that it be cooled as soon after milking as feasible, and that it be kept cool until consumed or used for the manufacture of milk products.

Cold checks the development of micro-organisms. The freezing temperature is, of course, better than 40° F.; 40° F. is better than 50° F.; 50° F. is better than 60° F.; 60° F. is better than 70° F.; and 70° F. is better than 90° F. for retarding the growth of micro-organisms. It follows from this that milk should be cooled at as low a temperature as possible immediately after milking and be *kept cool*.

To accomplish the cooling of milk, any cold, extensive surface over which the milk may run will be satisfactory if in a clean room. Ice should be used if possible; if this is not available, employ running cold water. If coolers, such as the Starr or Champion, are not procurable, a tank of cold running water into which sets the can of milk, may be very advantageously substituted, but it is not so valuable. Under such conditions the milk should be stirred continuously until cool, otherwise an hour or two will be necessary for lowering the temperature of the milk to that of the water. Time should not be wasted in this manner, for the micro-organisms are usually very active at this stage.

IX. MILKING IN THE STABLE.

Little need be said concerning this subject because what has already been hinted at in the discussion of the dust and dirt of the stable will be applicable; and, further, the absorption of gases has been mentioned under aëration and will furnish pertinent material. These are matters which serve as our reason for condemning the common practice of allowing open pails and open cans of milk which are still warm to stand in the stable. Such practices are especially bad after feeding or bedding because at such times the amount of dust and dirt is materially increased. If 3,600,000 germs can fall into a milk pail during five minutes, we

may ask how many will fall into a ten gallon can exposed in the stable while it is being filled by one milker?

Again, we have learned that milk absorbs gases. We know that constantly there are going off from fresh milk gases which are noticeable to our olfactory nerves. It must not be supposed that these gases pass off without others of the stable taking their place. It is an interchange of gases rather than a simple elimination of the cowy odors in the milk. Therefore, either from the standpoint of eliminating the germs, or from the standpoint of absorbing obnoxious gases from the stable, the practice of exposing milk in the stable is reprehensible.

X. STRAINING OF MILK.

Too much energy is expended upon the straining of milk. Does it seem rational to the milk producer that it is possible for him to intercept germs which are one ten-thousandth or one twenty-five-thousandth of an inch in length by a copper sieve with a one-sixteenth or a one-fortieth inch mesh; or by cheese-cloth, with its loose texture, even when used in folds four thick; or even by placing layers of cotton over the sieve? One might pertinently ask the question, "Is it possible to catch fish with a net whose meshes are large enough to allow a whole school of fish to pass through at once, or even intercept them by filling the stream with brush?" This is what is attempted with strainers of copper, cloth or cotton wool. What dirt is soluble will pass through, and it is true that what is insoluble will remain upon the filter, usually. Yet all the dirt which may be found upon a hair that has been arrested by the filter, has been washed off and through by the impinging streams. In other words, dirt which is insoluble or particles of hair, straw, hay, etc., which will not pass through the sieve or strainer are thoroughly washed upon the sieve by the impinging stream of milk, and the result is that all the dirt goes into the milk and these substances are left clean upon the sieve.

Conn, in his exhaustive work upon straining has shown by actual count that the number of germs in milk strained or unstrained is practically the same. It is fair to consider that straining removes what is visible to the eye, and one feels some satisfaction in not having particles of dirt, straw, and things of this nature passing down his throat while drinking milk. He does not think further and consider whether the objectionable features are in the milk or not.

XI. SANITATION OF THE STABLE AND DAIRY.

This old subject may not be so well defined as many newer ones, yet it cannot be passed over without giving it due consideration. It is important because several factors are involved, which, although not immediately perceptible, have a marked bearing upon some dairy practices.

Light should be admitted to the stable in abundance because it causes physiological vigor of the animals, checks fermentation and induces cleanly habits. This action of light is likewise useful in the dairy, for direct sunlight upon dairy utensils and the dairy room is as good as the best disinfectants.

Ventilation is necessary for perfect respiration of the animal, for the

exchange of the gas laden atmosphere of the stable with the pure air from without, that the animal may profit thereby and that absorption of obnoxious gases by milk may be eliminated.

Drainage is essential to reduce the amount of fermentation to the minimum, as well as to enable cleanliness and health to be maintained, for it is in the accumulated filth of the stable that fermentation is possible, consequently unsavory odors, gases and unsightly conditions.

OUTLINE FOR MILK MANAGEMENT.

1. The cow should be sound,—no disease should exist in the animal.
2. The feed should be good and free from aromatic substances. If these aromatic foods are used they should be employed according to those methods which will not cause odors or flavors to appear in the milk.
3. The cow should be groomed and hair about the udder preferably clipped.
4. The udder should be moistened during milking.
5. The milker should be a neat tidy person.
6. The milker should be free from disease and should not come in contact with any communicable disease.
7. The milker's hands and clothes should be clean while milking.
8. The pail should be sterilized.
9. The stall should be such as to reduce the amount of disturbance of dust and dirt.
10. There should be good light, good ventilation and good drainage in the stable.
11. The stable should always be kept clean.
12. Feeding and bedding, unless moist, should be done after milking.
13. A dustless milking room is desirable.
14. Milk should not stand in the stable.
15. If milk is aerated, it should be done before cooling and in pure air.
16. The sooner the milk is cooled after milking, the better.
17. Keep the milk as cold as possible when once cooled.

Laboratory of Bacteriology and Hygiene.

August 8, 1904.

PART II.

PRACTICAL CONDITIONS FOR THE PRODUCTION OF MILK.

JOHN MICHELS.

There is nothing of an original nature claimed for this bulletin, neither is it considered to be an exhaustive treatise of the subject under discussion, its aim being merely to throw out a few suggestions as they appeal to the practical dairyman. It is pertinent to the discussion to add that some of the phases of the subject as treated herein have been previously considered by Director C. D. Smith, not in bulletin form, but in the 1895 Report of the Board of Agriculture, which is now out of print. The increasing attention that milk production is receiving makes it exceedingly desirable that practical hints and cautions be sent out from time to time, regarding the economic production of pure milk, and this bulletin is submitted with this in view and in response to a demand that has of late become quite urgent.

In view of a persistent demand at present for the production of cleaner and purer milk, it has been deemed desirable to present in this bulletin some practical methods of securing it upon the average farm, in other words, under ordinary conditions. To aid in making the discussion of this subject as practicable as possible, the writer has visited the farms of several of the leading dairymen of the State, and has made a careful study of the methods in vogue. It is not proposed here to enter into a discussion of the methods employed in each of these dairies, for too much space would be required to set forth all that may be said to advantage, but it has been the purpose throughout to draw from each those lessons which may furnish to milk producers hints for their own practices, and to recommend those methods which are found to be employed by the best dairymen. That the material secured might be systematically arranged, we have endeavored to divide it as follows:

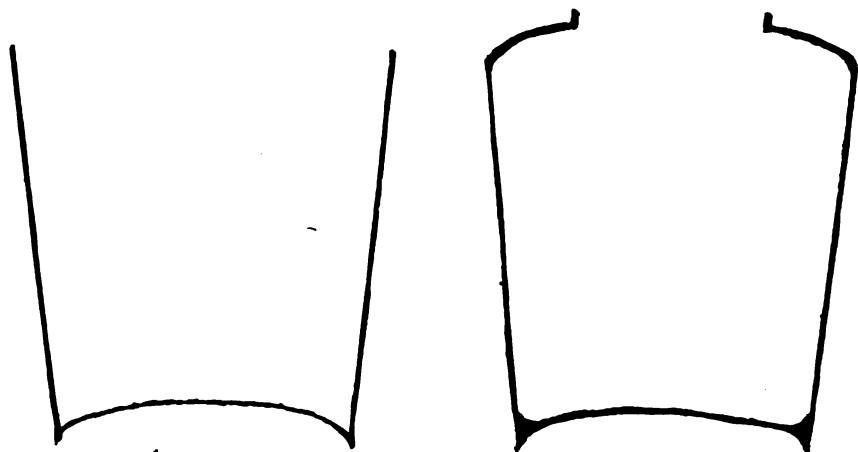
- I. Utensils Used in the Dairy.
- II. The Wash-Room.
- III. The Stable.
- IV. The Barn-Yard.
- V. The Cow.
- VI. The Milker.
- VII. The Care of the Milk after It Has Been Drawn.

I. UTENSILS USED IN THE DAIRY.

All utensils used in the handling of milk should be made of good tin, with as few seams as possible. Wherever seams occur, they should be flushed with solder. Unflushed seams afford excellent breeding places for

micro-organisms, and are doubtless the source of much trouble in the dairy. Figure I illustrates the character of the unflushed seam.

Figure II represents a flushed seam, which fully illustrates its value. This figure also represents a sanitary milk pail, with a partly closed top. It is modeled after that used by Gurler. The sanitary milk pail is further represented in Figure III, where it can easily be seen with



Figs. I. and II.

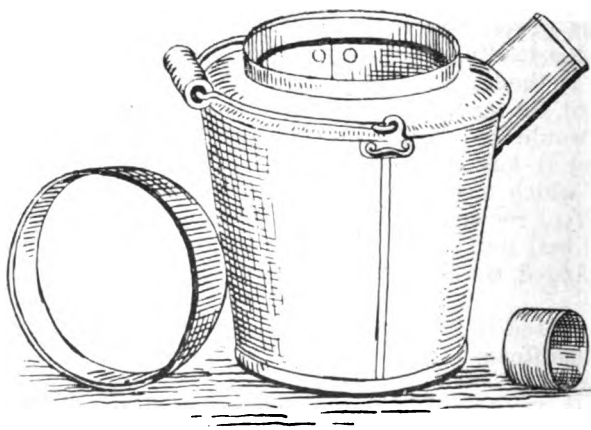


Fig. III.

its spout, which permits ready emptying, and it will also be noticed that it is covered with a cap during the process of milking. The cap is shown at the right. The ring at the left fastens the strainer, which should consist of a double layer of cheese cloth enclosing a layer of absorbent cotton. The purpose of the cotton is to retain fine hairs and

any particles of dirt that are not dissolved by the milk. It should be renewed at each milking. The value of a partially closed pail is evidenced by the reduced surface, which has a tendency to keep out many of the micro-organisms, which would otherwise drop into the pail during milking. To illustrate, a half closed top would have the effect of reducing the contamination from this source about fifty per cent.

It is well to say in this connection that there are many objections to the so-called sanitary milk pail. It without doubt reduces the contamination when the contamination occurs, but when cleanliness is rigorously practiced, no doubt the disadvantages exceed the benefits. (See Part I, page 62.) However, many of our best dairymen use it continually.

II. THE WASH ROOM.

A room for the purpose of washing the dairy utensils is a very important part of the equipment. It should be provided with shelves, some good washing substance, as sal soda, hot and cold water, and, if possible, steam. The shelves should be placed near a large window where the tin-ware is exposed to the disinfecting action of the sunlight. The cleaning of dairy utensils is best conducted as follows:

First, rinse with warm, or perhaps preferably cold water—never use boiling or hot water at first or the milk will become cemented to the utensil. Second, scrub with moderately hot water containing some sal soda. The washing should be done with brushes rather than cloth because the bristles enter into any crevices present which the cloth cannot possibly reach. Furthermore, it is very difficult to keep the cloth clean. Third, scald thoroughly with steam or hot water, after rinsing out the water in which the sal soda was used. After scalding, the utensils should be inverted on the shelves without wiping and allowed to remain in this place until ready to use. This will leave the vessels in a practically sterile condition. Fourth, if it is possible to turn the inside of the vessels to the sun, in a place where there is no dust, then it is desirable to expose the utensils during the day to the strong germicidal action of the direct sun's rays.

In washing strainers, or cloth used for straining, care should be exercised in placing these in boiling water a few minutes after thorough cleaning. From the boiling water they are spread out to dry in a clean and dustless place.

III. THE STABLE.

Light, ventilation, and ease of cleaning are essential to a sanitary stable. In order to secure light, underground stables must be avoided, and when the stables are above ground, a sufficient number of windows should be inserted. Remember that there is vigor of physiological growth and reduced decomposition by the introduction of sufficient light. Good ventilation is not secured unless better facilities are offered than the occasional admittance of air through doors and windows. This is especially true in the winter season. A continuous ventilating system, such as has been devised by Prof. King,* may be recommended with much confidence, because it has been successfully employed in many of the leading dairy barns of the country. This system may be briefly described as consisting of air shafts in the outer wall, which admit fresh

*See "Physics of Agriculture," pp. 355-357, by Prof. F. H. King, Madison, Wis.

air. An opening near the floor carries it up to a point near the ceiling, where it is discharged into the barn. Impure air is removed by flues opening near the stable floor, and extending through the roof of the barn.

That easy and thorough cleaning of floors may be assured, it is desirable that the mangers and gutters be built of concrete. The floor of a truly sanitary stable must not only be daily freed from manure, but must also receive a daily scrubbing. The walls and ceiling should be kept free from dust and cobwebs and should be whitewashed at least once each month. Lime is a good absorbent of odors, and may be advantageously employed in the gutters. It checks fermentation, also.

Should any fermented foods, decomposed substances, or highly aromatic foods be left about the barn, or stable, the odors or aromas arising from such materials are likely to be absorbed by the milk. The surroundings of the barn should be kept perfectly clean, for cleanliness means pure air, better stables, and clean milk.

The stalls of a stable are a very important item. They should be built for the purpose of keeping the cow clean, of protecting her, and of giving her as much comfort as possible. It is also desirable that the stall be of such a nature as not to cause any disturbance to the milker or produce dust by his movements. That the cow may be kept clean, her position in the stall should place her hind feet on the edge of the gutter. In order to have comfort, she should not be confined in a rigid stanchion. These purposes may be accomplished by a stall closed in the rear with a chain, as shown in Figures IV and V, or tied in a half stall, after the fashion shown in Figure VI.

Figure IV illustrates an iron stall, in which the cow is not tied in any manner, but held in position by means of a chain in the rear. This is known as the Drown stall. While possessing all that is desirable in an ideal stall, its cost, which is about \$9.00, makes it quite impracticable upon many farms. The wood stall of similar construction, by the same patentee, costs less than half this amount. The patentee receives a royalty of fifty cents. It should also be mentioned that the gates shown in the illustration may be raised up as well as moved out.

Figure V shows a stall quite similar to this excepting the wood which is used in its structure. This is known as the Bidwell stall. The manger is movable, and the stall may be adjusted to suit small as well as large cows. This stall, including a fifty cent royalty, should not cost above \$3.50.

Both of the above stalls are comfortable, and will keep cows clean. The cows stand close to the gutter, but, owing to the chain in the rear, cannot step into it. It should be stated, in this connection, that where the partition is complete between the cows, there is a serious objection arising because the milker entering a stall of this nature, may cause more or less dirt to fall into the pail, or will cause dust to rise which will get into the milk during milking. A precaution necessary in constructing these stalls is to have the posts as close to the edge of the gutter as possible.

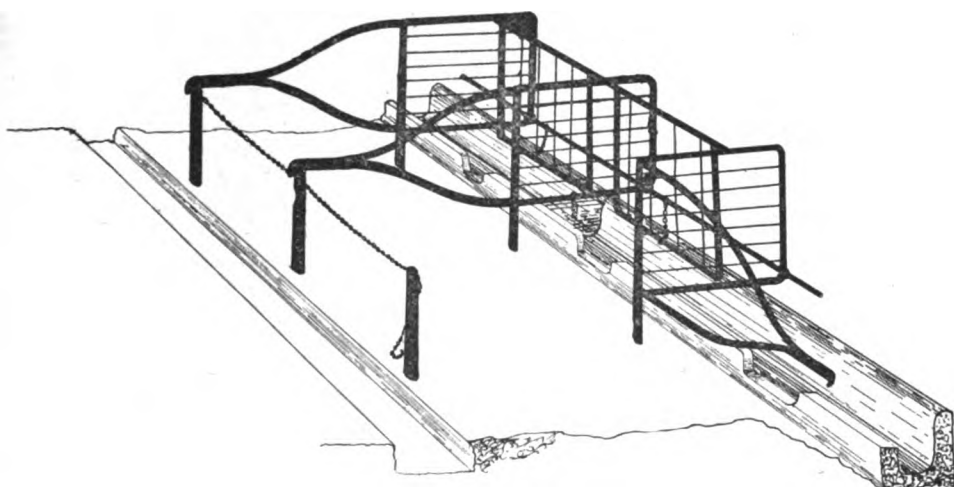


Fig. IV.

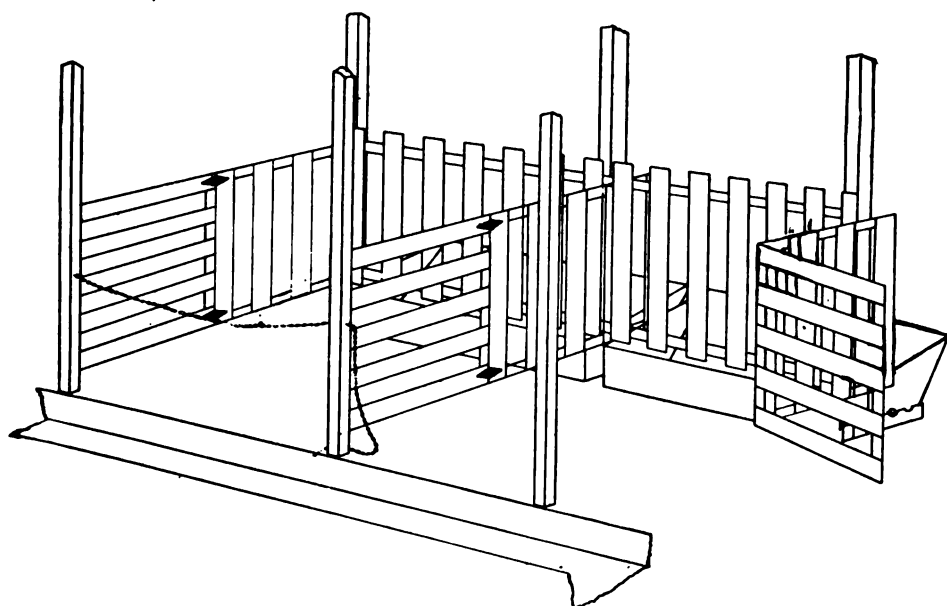


Fig. V.

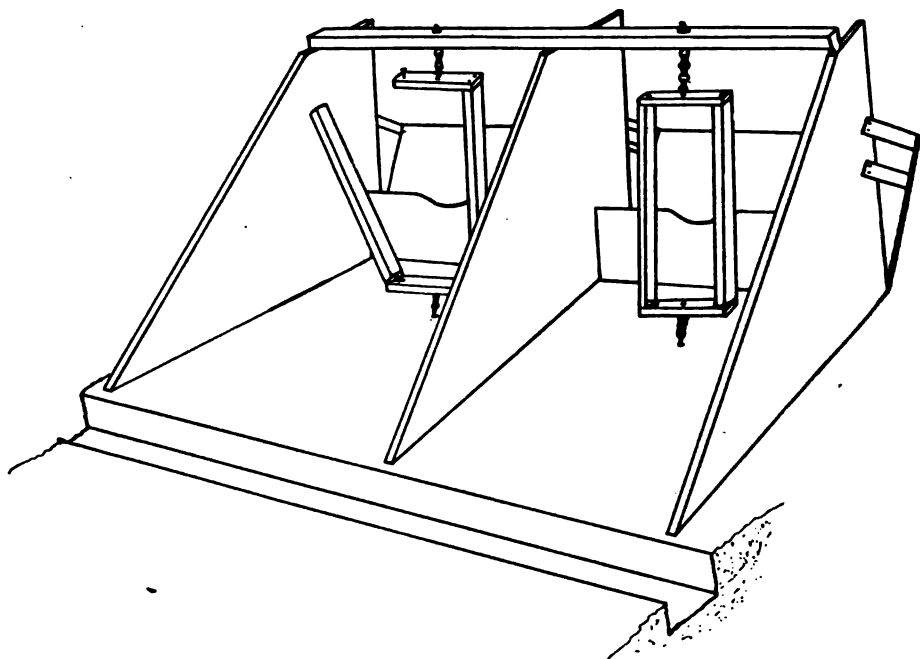


Fig. VI.

Figure VI shows a half stall which has been endorsed by many leading dairymen. With this stall, however, cows will occasionally step back into the gutter, especially when tied in front with chain or rope.

There is also a possibility of the cows treading on each other and doing injury in these stalls, as well as when the stanchions alone are used without the presence of any partition.

IV. THE BARNYARD.

A clean well-drained barnyard is an essential factor in the production of sanitary milk, for where cows are obliged to wade in mire and filth, it is easy to foretell what the quality of the milk will be. In order to secure a good barnyard, the slope should be away from the stable, or at least not towards the stable, and it should be covered with gravel or cinders. If the manure is not taken directly from the stables to the fields, it should be placed where the cows cannot have access to it.

V. THE COW.

Ordinarily, when milking, a great number of bacteria will find their way into the milk through the dust and dirt and hairs which fall from the cow. This may be largely prevented by wiping the flanks and udder with a moist sponge or cloth just before milking. It is still better to wash; however, this procedure requires more time, as it must be followed by careful wiping to prevent dripping. Cows should not be bedded, fed, or carded, just before milking, as any one of these acts creates dust which will certainly find its way into the milk. If pure milk is sought,

it is desirable to reject the first streams of milk from each test, as these contain thousands of bacteria. The reason for this rich development of germs is found in the favorable conditions provided by the milk in the milk-cistern of the udder, and also by the possible access of the germs through the milk-duct.

VI. THE MILKER.

Clothes which have been worn in the fields during the day are not suitable for milking purposes. Every milker should be provided with a clean, white milking suit, like that illustrated in Figure VII. Such

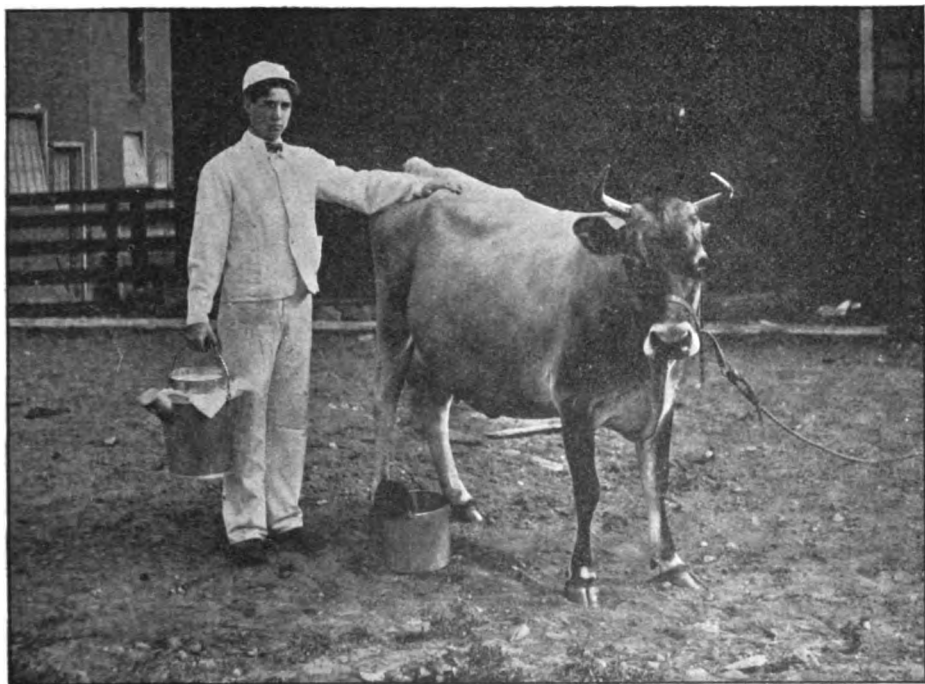


Fig. VII.

clothes can be bought ready-made for less than a dollar; and, if frequently washed, will aid in securing clean milk. Milkers should also wash and dry their hands before milking, and, above all, should keep them dry during milking. To wet the hands with the milk is a filthy practice.

VII. THE CARE OF THE MILK AFTER IT IS DRAWN.

Immediately after milking, the milk should be removed from the barn to a clean, pure atmosphere, where it is aerated and cooled by running it over a combined aerator and cooler of the type shown in Figures VIII and IX. If it is possible to aerate the milk while warm, should aeration be desired, better results will be obtained than where aeration and cooling are attempted in the same process and at the same time. The barrel shown in Figure VIII is filled with cold water, which circu-

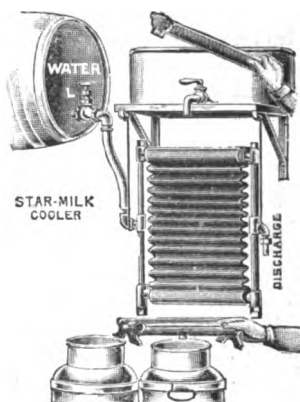


Fig. VIII.

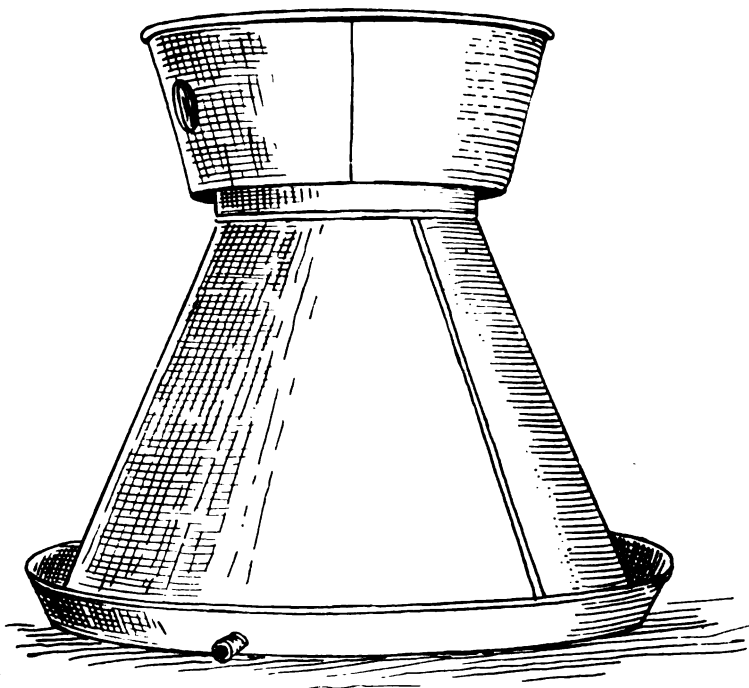


Fig. IX.

lates between the two tinned surfaces of the cooler, over which the milk flows in thin sheets. By this means it is possible to reduce the temperature of the milk at least to within five degrees of the temperature of the water used for cooling. The cooler shown in Figure IX allows cold water to enter at the bottom and the warm water to overflow at the top, while the milk flows in a thin sheet over the outside of the cooler. If ice is at hand, it is desirable to use it in both cooling apparatus.

Always keep aerators and coolers as clean as any other dairy utensils.

BULLETIN 222

DECEMBER, 1904

MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DIVISION OF ENTOMOLOGY

THE
CODLING-MOTH IN MICHIGAN

BY
RUFUS H. PETTIT

MAY 20 1905

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THE CODLING-MOTH IN MICHIGAN.

R. H. PETTIT, ENTOMOLOGIST.

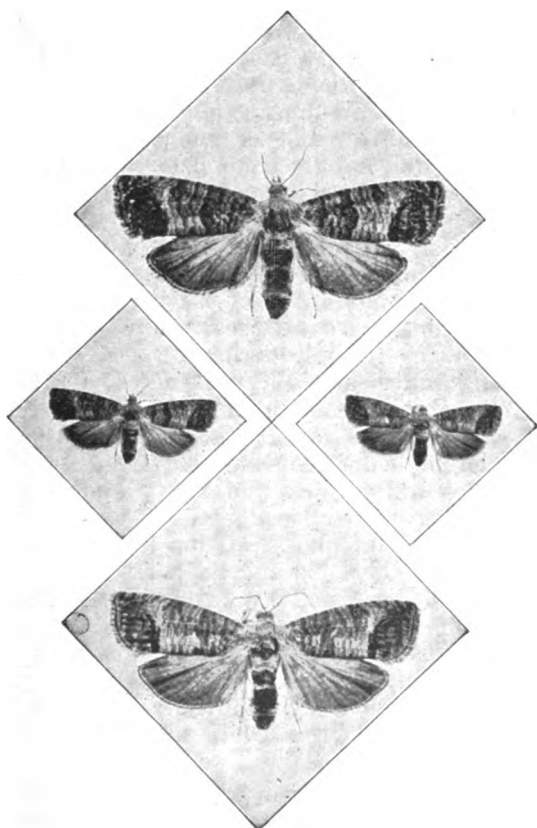


Fig. 1.—Codling-moths, the upper and lower ones enlarged. From Slingerland, Cornell University Experiment Station.

While the present bulletin will be found to contain very little that has not been worked over before, it is based on observations made in Michigan. Very careful studies have been made by Professor M. V. Slingerland of Cornell University, by Professor J. M. Aldrich of the

Idaho Agricultural College, by Professor Fred W. Card, formerly of Nebraska, and more recently, by Mr. C. B. Simpson of the Department of Agriculture, who has published an extensive and exhaustive monograph on the subject.

The field work has been done almost entirely by student assistants, Mr. H. F. Tuttle during the summer of 1903, and by Mr. V. R. Gardner in 1904. Their careful and painstaking labor has made it possible to carry on the work.

The present activity in horticultural circles and the recent work of Simpson, Slingerland, Aldrich, Card and others, has brought the question of the control of the codling-moth very forcibly to our notice. Furthermore, in making recommendations for the treatment of trees, it became apparent that many points in the life-history of the creature were only to be guessed at in this, the most northerly State of the middle United States, where the pest is common. It is so important indeed that the depredations of all other apple insects sink into insignificance when compared with it,—so serious that half or more of the apple crop is sacrificed annually to its inroads. Furthermore, conditions vary so widely in the great apple growing regions of our country, that data collected in different localities and in different latitudes, might be so widely at variance that they would be of little value except in the immediate regions where they were obtained.

Early in the spring of 1903, it was decided to start a series of observations which should, if possible, give us reliable information on the number of broods, the times when they occur, and the effects of a spray applied just when the second brood of larvae were ready to enter the fruit. These observations have been carried on over a space of two seasons, and the following results obtained:

In order to understand clearly the sequence of the broods, it will be necessary to review briefly the life-history of the creature.

The winter is passed in the larval condition enclosed in a cocoon of white silk, in which is bound considerable frass or chewed up fibre. This winter cocoon is quite thick and heavy and ordinarily is to be found neatly hidden away under loose pieces of bark, beneath fence-rails, under branches and in similar places. Often the cocoon possesses only a very thin film of silk next the wood and the bark, most of the material being used in making a ring between these two surfaces. The cocoon is about half an inch long and oval in form, just occupying the space allowed. Often, a tube extends from the outer more roomy part under the flake, down to the thin part of the wedge-shaped opening where the cocoon is placed, the larva in such a case, having commenced to spin where the space was too large, had crowded in toward the narrower part as it built.

Diligent search was made for these cocoons, in the spring of 1903, and two in good condition were found. A quantity of empty ones came to light, the larvae having been picked out by birds during the winter. These two cocoons were placed in cages and while their transformations may have been somewhat hastened by reason of being brought into the house, there is reason to believe that adults out of doors emerged soon afterwards. The two emerged on May 22. On June 12, I found eggs and young larvae. It may be well to state that on May 25, the blooms

on the trees had practically all fallen, for on that date the spraying of the College orchard commenced.

The codling-moth, as everyone knows, has very poorly defined broods, the members of a single generation becoming adults over a considerable range of time, and not emerging all together as in the case of the canker-worm and many other insects. The most that could be hoped for would be to ascertain the top of the wave of prevalence of the insect in each stage, thus it is very desirable to know just when the greatest number of the eggs hatch, when the spinning of the cocoons is most actively carried on, etc., and these things for each generation. With these facts at hand, it is much easier to so time the application of the sprays as to catch the greatest number of young larvae just entering the fruit.

Simpson, in his bulletin number 41, of the Division of Entomology, gives fifty-five to fifty-eight days as the average time required for the moth to complete its life cycle, and counting backward from June 12, the time when the eggs and young larvae predominated, we find that our two moths probably emerged before the majority of those out of doors. We have set June 1 as about the right time. Counting ahead 57 days, we get the date of the emergence of the adults of the second generation on about July 27, and in our cages containing freshly collected cocoons, we get the greatest number of adults at this time.

A schedule made up partially from our observations in 1903, and partly from calculations, using fifty-seven days as an average time for the completion of the life cycle, would look something like this:—

FIRST GENERATION.

First adults, May 22 (blooms falling about May 25).

Most adults, June 1.

Most eggs, June 9.

Most eggs and young larvae, June 12.

Most larvae, June 15.

Most spun up in cocoons, July 12.

SECOND GENERATION.

Most adults, July 27 (shown in cages from fresh cocoons).

Most eggs, August 6. (Spray at this time.)

Most larvae, August 11. (Young larvae shown in orchard.)

Most cocoons just spun up, September 2.

POSSIBLE THIRD GENERATION, FROM COMPUTATION, AND NOT FROM OBSERVATION.

Most adults, September 23, (due at this time).

Most eggs, October 1, (due at this time).

Most larvae, October 6, (due at this time).

In his work on the codling-moth, Mr. Simpson refers constantly to the bands placed about the trunks of trees for the purpose of providing suitable places for the larvae to pupate. By the use of these bands, he was able to get reliable and indisputable data on the time of pupation at least. By daily counts he readily determined the exact times when the larvae went in as well as when the adults came out. We tried these bands made of burlap, but with very indifferent success in 1903, over half of the larvae not caring to utilize them but preferring for the most part, to pupate under loose flakes of bark instead. For this reason, we were obliged to substitute some other plans for keeping counts. The orchard which we used was a large one, and one that contained trees of all ages, so we determined to spend about the same amount of time and labor each day in searching for the larvae which were just spinning up in cocoons, and for the eggs and young larvae on or in the fruit. This plan would seem at first to be very crude and to promise little in the way of accuracy, but when we consider further that each count is double in character, and that cocoons are compared each day with larvae, and that eggs are compared with young larvae, that the emergence of the adults is checked by cage experiments, we will find that while the method may be inferior to that of banding, it does readily give us useful facts and with a fair degree of accuracy. Our bands failed because the flakes of bark offered more desirable quarters. During 1904, we selected ten trees in an old orchard which was not to be sprayed, and scraped off all flakes and scales, thus driving most of the larvae under the bands. We also obtained more accurate information relating to the time of the first appearance of the adults in the spring.

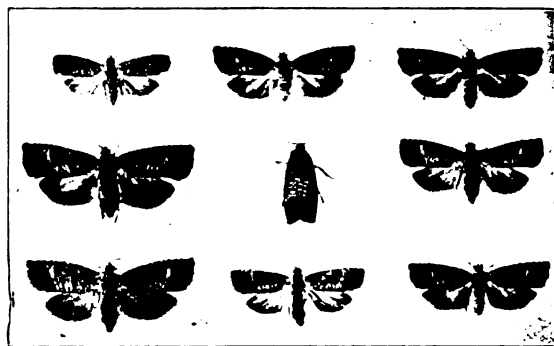


Fig. 2.—Codling-moths. From Slingerland.

In order to collect evidence relative to a possible third brood, two trees, unsprayed except for the first spraying, in the College orchard, were carefully gone over and all wormy fruit removed on September 18 and 19, just before the adults of the third brood might be expected, if at all; a glance at the schedule will show September 23 as the estimated date for the adults of the third brood. On October 17 and 24, the apples were picked from one of these trees and each examined

for larvae. Many tiny larvae were present as well as a number of quarter grown ones of various sizes ranging between. It was therefore impossible to determine in this way, whether the larvae found, were the offspring of belated moths of the second generation or members of the third generation. We know that there is a wide range of time over which the adults come out and it is not at all impossible that these larvae were the late arrivals of the second generation which were getting ready to pass the winter in the barrels after picking. An examination of the wormy apples picked on September 19 showed that out of 800 larvae, 150 entered at the calyx, and about 650 elsewhere, or a little under 19% at the calyx or blossom end, as against 26.1% obtained by Simpson from a more extended series of counts, for the second brood. Our counts for 1904 give a very different result.

When the point of entrance is other than at the calyx, the commencement of the tunnel is often where two apples touch or where an apple and a leaf touch. In our cages, the eggs were laid indiscriminately on glass, foliage and some on fruit, the moth seeming to greatly prefer glass.

The experience of 1903, led to a modification of the plans in 1904. The use of ten trees in an old, unsprayed but bearing orchard was obtained, and these trees were carefully scraped, all the loose bark being removed with a steel scraper while moist, and bands of burlap were loosely fastened, one or two about the trunk of each tree. These were utilized by the larvae for shelters under which to spin cocoons. Under these conditions, it was easy to find with precision, the dates when the larvae spun up, and by collecting the cocoons, and placing them in cages, it was easy to find just when the adults emerged. Counts were made from time to time,—every one, two or three days, and each time a count was made, the total number of cocoons found was divided by the number of days intervening between that count and the one immediately preceding, so that a very good average was obtained.

The season of 1904 was at least ten days late. Furthermore, at the time of the first spraying, the weather was wet and the stamens were slow in drying and curling up, remaining instead and filling up the calyx so that poison could not penetrate. Everything was delayed throughout the season, so that dates obtained this year may with safety be put back about a week.

The calendar for the codling-moth for this season would look something like this:—

FIRST GENERATION (1904).

Pupation most active, May 16, (about half larvae and half pupae).

Sprayed, June 3. (Petals falling or fallen.)

First adult, June 4.

Most adults, June 10-12.

First larvae entering apples, June 22.

Most larvae entering apples, July 5.

First cocoons, July 11.

Most cocoons, July 20.

SECOND GENERATION.

First adult, July 30.

Most adults, August 5 (in cages).

First eggs, August 3.

Sprayed trees, August 9.

Most eggs, August 26 (well marked).

Larvae entering in large numbers, August 26 to September 7.

Most cocoons, September 28-30.

This table has been compiled from a mass of data collected in various ways from the field and laboratory, breeding-cages, etc., and there is reason to believe that it will not come far amiss for 1904, in our State. Of course each brood extends over a long period of time and the broods overlap very badly.

Following is a table giving the results of the examination of bands for the season. It gives the number of larvae that enter the bands each day for the purpose of spinning cocoons. Each cocoon as soon as found, was of course removed or destroyed.

From July 13 to August 5, hogs were in the orchard, also from September 6 to October 7. Considerable brush lay on the ground under the trees from early pruning time until about September 6 when it was removed.

BAND RECORD FOR 1904.

Date.	Number of cocoons.	Average number daily.
July 11	2	2
13	5	2½
15	16	8
16	5	5
18	19	9½
19	11	11
20	24	24
21	19	19
22	18	18
23	20	20
25	30	15
26	16	16
27	18	18
28	10	10
29	7	7
30	13	13
Aug. 1	11	5½
2	8	8
3	2	2
4	6	6
5	3	3
8	13	4⅓
10	4	2
11	2	2

BAND RECORD FOR 1904.—Continued.

Date.	Number of cocoons.	Average number daily.
12	3	3
13	3	3
15	5	2½
16	1	1
18	2	1
20	1	½
23	7	2⅓
26	6	2
29	6	2
31	0	0
Sept. 3	3	1
6	2	⅔
8	1	½
10	3	1½
12	3	1½
14	7	3½
16	8	4
17	4	4
19	30	15
21	13	6½
22	0	0
26	44	11
28	39	19½
30	47	23½
Oct. 1	13	13
3	19	9½
6	19	6⅓
8	15	7½
12	80	20
18	50	8⅓
21	52	17⅓
26	6	1
29	6	2
Nov. 2	10	2½
8	14	2⅓

In order to get an estimate as to the times when the larvae entered the apples in greatest numbers, examinations of the fruit were made at short intervals. Fifty apples were picked at random from an unsprayed tree at each examination, and these were cut open to make sure whether they contained larvae or not. The variation is accounted for when we consider that the apples were picked from various parts of the tree.

Following is the result of these counts for 1904:—

NUMBER OF LARVÆ ENTERING APPLES, 1904.

Date.	Number found.	Just entering.
June 10	0	
20	0	
22	2	
24	6	
27	7	
30	8	
July 2	12	
5	8	
6	17	
8	14	
9	18	
11	17	
13	21	
15	20	
18	21	
20	18	4
25	12	2
27	21	4
29	22	8
30	13	5
Aug. 1	13	3
3	21	3
10	11	7
11	18	5
13	21	6
15	22	10
16	19	9
20	20	15
26	30	20
29	30	14
31	27	7
Sept. 3	30	10
6	37	8
8	37	9
10	19	6
12	26	3
14	23	1
16	24	1
17	26	1
19	27	0
21	28	4
22	35	1
28	33	4
30	29	0
Oct. 1	27	2
6	31	0
18	24	1
21	36	0

On September 10 a change was made in the tree from which the counts were made, it being impossible to obtain more apples from the original tree used (a Shiawassee). The rest of the counts were made from a russet in the orchard where the bands were placed.

Toward the latter end of the season, great numbers of the wormy apples fell, thus reducing the count very materially. The tree being a russet. This accounts for the apparent discrepancy between this count and the count from the entire trees, which latter was made from spies.

THE PLACE OF ENTRY.

During the season of 1903, a large proportion of the whole number of larvae entered at the calyx or blossom end of the fruit in the first brood, and 19% was the proportion of the second brood entering at the calyx, as based on a count of 800 larvae made on September 19, 1903. Strangely enough, in 1904, a similar count for the first brood, made from 450 apples, gave 28 from the side and 64 from the blossom end or about 30% from the side. On the other hand, a count of 1,000 apples, taken on August 31 and afterward, gave 235 from the side and 440 from the blossom end, or nearly 35% from the side. These counts were, of course, made on a small number of apples, but at the same time, they are suggestive.

THE EGG.

Description—The egg is flat and scale-like, being less than 1-16 of an inch in diameter. It is at first, pearly, later becoming yellowish. It requires at all times close observation to find it.

In order to make the calendar of the moth more complete, a short series of observations were made on the times of greatest activity in egg laying. In interpreting the counts given it should be remembered that some of the eggs were probably hatched. Then, too, those found very late in the season may have been laid some time before, the cool weather preventing them from hatching at all. The following table gives also some comparison as to the relative number laid on the fruit and on the leaves. The number of leaves and apples examined, was fifty each on each date, except August 3, when 100 leaves were examined.

THE EGG LAYING OF THE SECOND BROOD, 1904.

Date.	No. of eggs found on fruit.	No. of eggs found on leaves.
Aug. 3	3	1
4	..	2
10	..	6
11	12	7
12	..	7
13	9	2
15	22	4
16	16	4
20	20	
23	..	9
26	38	13
27	..	1
29	29	4
31	19	8
Sept. 3	22	3
6	30	5
8	16	
10	10	2
12	5	1
14	7	
16	12	1
17	5	1
19	9	1
21	6	0
22	6	3
28	13	0
30	9	0
Oct. 1	8	4
6	7	3
18	5	2

A comparison between these figures shows that in an equal number of fruits and leaves, viz., 1,150 of each, nearly 19% of the eggs were laid on the leaves.

In order to get an idea of the proportion of eggs that were laid on the foliage as a whole as compared with the number laid on the fruit, a count was made of the leaves and fruits on a part of a good bearing tree in the College orchard. On September 15, 1904, a limb $3\frac{1}{8}$ inches in diameter, which had been split from the tree by the wind, was removed from the tree and each leaf and apple picked off and counted at the time. The result was as follows,—986 apples and 26,395 leaves, or 26.8 times as many leaves as apples. A count of 1,150 leaves and 1,150 apples, gave us 69 eggs laid on the leaves and 295 eggs laid on the apples. This gives us 13.76% of the eggs laid on the fruit as against 86.24% on the foliage. Furthermore, the young larvae were found to feed on the underside of the leaves, removing small patches of the soft

tissue. This helps to explain why the August spray is so efficient, for it is much easier to make the spray cover and stick to a leaf, than to an apple.

EXPERIMENT IN SPRAYING FOR THE CODLING-MOTH.

In order to put to a practical test, the effect of two sprays, applied as indicated by the calendar, permission was obtained to spray an orchard of about forty trees, in the vicinity of the College. Accordingly a spray of paris-green and bordeaux was applied, using four pounds of copper sulphate, six pounds of lime and 40 gallons of water, to which was added four ounces of paris-green. This was carefully put on on June 3, 1904. A second spray was applied on August 9, using four ounces of paris-green and eight ounces of lime to 40 gallons of water. Examinations of 60 apples made on July 13 showed three larvae or 5%, there were evidences of more which had entered into the calyx, but had died there. Another examination on August 31 showed three live larvae with three more that had died in trying to gain entrance.

On October 15, 1904, three trees were picked and the fruit sorted as carefully as possible without cutting open each apple. One tree (No. III) was unsprayed because of its location, being difficult to get at. This tree was the best one of a group of four unsprayed trees standing near together. It had borne well and would have produced a fine lot of fruit had it received the same treatment as the others. The fruit was, however, scabby, and a large number of wormy apples had fallen. The variety of trees I to V was Northern Spy. A count from this tree gave the following result:

TREE III.—UNSPRAYED, IN SPRAYED ORCHARD.

Yield	12 bu.
No. of apples.....	1,560
Not wormy	897
Wormy	663
Per cent wormy.....	42.5

The reason for the vastly superior yield of this tree over that of trees IV and V, in the unsprayed orchard is easy to see. The sprayed orchard was better pruned, cultivated, and fertilized, and the percentage of sound fruits was raised because great numbers of the moths from this tree spread themselves over the rest of the orchard, while few moths from other trees came to this one. The difference in the yield was largely due to culture, but the difference in the percentage of wormy fruit was largely due to the fact that the surrounding trees were well sprayed.

Two other trees that had been sprayed twice, as previously described, were examined on the same day. Tree I was considerably further away from tree III than tree II. An examination of tree II gave the following results. There was little scab.

TREE II.—SPRAYED TWICE.

Yield	13 bu.
No. of apples.....	1,706
Not wormy	1,483
Wormy	223
Per cent wormy.....	13.07

Tree I gave the following results. It was in the same orchard but more distant from tree III than tree II. There was little scab:

TREE I.—SPRAYED.

Yield	12 bu.
No. of apples.....	1,883
Not wormy	1,750
Wormy	133
Per cent wormy.....	7.06

This shows great superiority in salable fruit in the case of the sprayed orchard.

Counts made from two trees in an unsprayed orchard, the one in which we had banded trees, were made on October 8. Two Northern Spy trees were selected, as this was the only variety common to both orchards, which had trees of approximately the same size, and also because the Spy is standard in Michigan. The outputs of these two trees were classed together, being rather light. The result was as follows:

TREES IV AND V.—UNSPRAYED, IN UNSPRAYED ORCHARD.

Yield	7½ bu.
No. of apples.....	1,054
Not wormy	114
Wormy	940
Per cent wormy.....	89.3

There was much scab on the fruit and many windfalls. This helped to pull down the yield very appreciably. The fruit in no case was cut open, but judged as well as possible from outside appearances.

THE THIRD BROOD.

The work of the present season seems to indicate two annual generations rather than three. It was at first thought that the presence of young larvae in the apples in October, which had appeared just when the third brood would have been due, was very suggestive of a third brood, but the counts made in 1904, showing the waves of pupation, etc., do not

bear out this theory. If there were a third brood, one would expect to find a corresponding wave of pupae and adults, furthermore, in our observations, the October larvae were not of a uniform size, grading instead from very small individuals to those of considerable size. The fact remains, however, that larvae *do* enter the fruit late in the season, working in considerable numbers even after the apples have been packed and sold.

NATURAL ENEMIES.

Beside a number of parasites which infest the codling-moth, we find here a fungus disease (*Isaria farinosa*) which was separated out and grown in pure culture by the writer during the season of 1903, and which fungus killed other larvae that were brought in contact with the culture. An attempt to collect winter cocoons called attention to the fact that birds play an important part in keeping down the insect. Most of the cocoons found in the spring were concealed beneath flakes of loose bark, and in almost every case, a hole through the bark flake to the inside of the cocoon, showed an opening through which the larvae had been extracted.



Fig. 3.—Inner surface of a flake of bark, showing cocoon of codling-moth, enlarged, and the hole pierced by woodpecker in extracting the larvæ.

Such pierced cocoons are the common thing in our orchards, especially is this true in all cases where they have been placed high enough to be above the snow line. Those placed below the level of the snow are more or less protected and are more likely to escape. For this reason it will be good practice to scrape off in the fall all loose flakes below the level of the snow.

Some parasitic hymenoptera were bred from cocoons collected from under the bands.

Large numbers that winter under fences, brush, etc., are doubtless eaten by shrews, which are quite plentiful in Michigan orchards.

FUMIGATION OF STORAGE HOUSES.

Great numbers pass the winter in storage houses, in cellars where apples are stored, in old barrels, etc. Fumigation with sulphur, at the rate of three pounds to 1,000 cubic feet of air-space should rid a cellar or storage house of the pests.

SPRAYING.

Spraying is an old remedy but one that is very effectual, and by far the best means at hand. A spray of paris-green put on while the apple stands upright and before it turns down, after the blossoms fall and the stamens wither, will deposit a small amount of poison inside the calyx cup, which poison after a short time, dries and remains indefinitely. Now as the majority of the first brood and sometimes the second brood as well, enter at the calyx, the poison could not be better placed. Early in the season, fruit tunneled by the codling-moth, falls to the ground, thus thinning the fruit and saving the tree from the drain of supporting damaged fruit, but later, in the case of the second brood, the case is different. The larvae get into the fruit, much of which rots, while some appears to be healthy until after it is packed and stored away, where the larvae finish their development slowly and spin cocoons in the barrels or bins. The first brood does less damage than the second, but the size of the second brood depends largely on the proportion of the first brood that lives through. A spray applied just about the time that the young hatch out, during the first week of August, should and does reduce the second brood very materially. The reason for this is found in the fact that the majority of the eggs are laid on the leaves, which readily take and retain the poison. The fact that the larvae feed, for the most part, on the underside of the leaves, makes the advantage of under spraying apparent. If more than two sprays are to be applied, they may be put on, one soon after the first application and the other about ten days or two weeks after the first August spray, the period midway between the two, being a time of comparative inactivity.

Clean culture pays without question. Clods furnish places for the larvae to pupate, and brush and prunings furnish favorite quarters for such purposes. Many cocoons were found under brush, and trees under which brush was allowed to lie, showed a corresponding decrease in the number of cocoons under the bark-flakes and bands.

PREPARATION OF INSECTICIDES.

Any one of a number of arsenical sprays may be used in connection with bordeaux mixture for the codling-moth, but paris-green is rather a favorite with the writer because of its cheapness and because its color does not permit it to be mistaken for flour, baking-powder or any other common household commodity. In the case of large growers, the

cost of paris-green would be considerably more than Kedzie mixture or of white arsenic and lime. Directions for making these insecticides can be found in special bulletin 24, which is to be had for the asking. Disparane is purchased ready prepared and is said to have a great advantage in that it sticks longer than paris-green or any of the other arsenicals. Its cost is, however, somewhat greater.

The writer makes bordeaux and paris-green as follows: Four pounds of copper sulphate (blue vitriol) are dissolved in a wooden pail filled with hot water, and six pounds of stone lime (quick-lime) are slaked as finely as possible in a metal pail, with hot water. When ready stir the contents of each pail in a separate barrel containing twenty gallons of water. Now pour one pailful at a time, into the spraying barrel, taking alternately from these two half filled barrels, stirring well all the time. In this way a bordeaux of fine quality is made. To prepare the paris-green, place one-fourth to one-half pound of the unslaked lime in a small pail or crock and slake it with hot water. When reduced to the consistency of cream, add one-fourth pound of paris-green and stir with care, while the lime is hot. Add this to the forty gallons of bordeaux, stir in well and spray.

The copper sulphate should always be kept in wood as it quickly spoils if it comes in contact with metal. The easiest way to dissolve it is to suspend the crystals in a cloth bag just under the surface of the water. It dissolves much faster than if placed on the bottom of the vessel. When large quantities are to be made, it is well to make up a stock solution, dissolving a pound of the sulphate in each gallon of water in a separate barrel, so that a gallon of the liquid contains a pound of the crystals, in each case. This saves time, for we simply have to dip out four gallons of the stock solution, dilute to twenty gallons, and proceed as before. Several crocks or small pails may be kept going all the time, so as always to have a prepared stock on hand.

When large tanks are used of course larger amounts must be used, in the same proportion.

Use a fairly fine nozzle like a Vermorel, and stop spraying just before the tree commences to drip. When using the paris-green alone, mix with freshly slaked hot lime as described, only put it directly into forty-two or three gallons of water instead of forty gallons of bordeaux.

SPECIAL NOTICE.

Copies of the bulletins named below will be sent on application. Of all others the supply is nearly if not entirely exhausted.

A. M. BROWN, Secretary.

SPECIAL BULLETINS.

- | | |
|---------|--|
| No. | |
| 2 | Pests of house and ornamental plants. |
| 4 | Apple orchard spraying, when and how. |
| 5 | Forecast of Frost. |
| 7 | San Jose scale. |
| 8 | Planting sugar beets. |
| 9 | Farm accounts. |
| 10 | Sugar beets. |
| 13 | A review of Prof. Bang's work on contagious abortion. |
| 14 | Foul brood. |
| 16 | Aeration of milk. |
| | When and What to Spray. |
| | Prevention of Potato Scab. |
| | Elementary Science Bulletin, numbers 1-6. |
| 17 | Mosquitoes and other insects of year 1902. |
| 18 | Sugar beets in Upper Peninsula. |
| 20 | Report of the Upper Peninsula Sub-Station for 1901-02. |
| 21 | Cheese Problems. |
| 22 | The crop of corn. |
| 23 | A Preliminary note on the Associative Action of bacteria in the souring of milk and in other milk fermentations. |
| 24 | Insects injurious to fruits in Michigan. |
| 25 | Fungus diseases of fruits in Michigan. |
| 26 | Spraying calendar 1904. |
| 27 | Report of South Haven Sub-Station for 1903. |
| 28 | Report of the Upper Peninsula Sub-Station for 1903. |
| 29 | Additional work upon the Associative Action of bacteria in the souring of milk and in other milk fermentations. |
| 83 | Insecticides and fungicides. |
| 88 | Fruit report. |
| 90 | Vegetable tests. |
| 91 | Two plants for sandy land, spurry, flat pea. |
| 98 | Locusts and the horn fly. |
| 117 | Millet. |
| 118 | Fruits at South Haven. |
| 142-4 | (One volume) Fruit Tests. Fruits at South Haven. |
| | Vegetables, old and new. |
| 146-7 | (One volume) Bacteria and the dairy. |
| | Pasteurization of milk. |
| 150 | Sugar beets in Michigan in 1897. |
| 162 | Forestry. |
| 163 | Strawberry Culture. |
| 170-171 | (One volume) Bush fruits for 1898. Notes from South Haven Sub-Station. |
| 172-3 | (One volume) Combating Disease-producing Germs. |
| | Killing the Tubercle Bacillus in milk. |
| 175 | Some Insects of the year 1898. |
| 186 | First Report of the Upper Peninsula. |
| | Experiment Station. |

- 189 Notes on Strawberries.
- 190 Vegetable Tests for 1900.
- 192 Fertilizer Analysis (1901.)
- 193 Some experiments with beet pulp as a stock food.
- 194 Report of South Haven Sub-Station for 1901.
- 197 Sugar beet experiments.
- 198 Sand lucerne.
- 199 Cow peas, soy beans, and winter vetch.
- 200 Some Insects of the year 1901.
- 201 Aeration of milk (summary of special No. 16.)
- 202 Fertilizer analysis (1902.)
- 204 Mosquitoes and other Insects of year 1902.
- 208 Michigan Mushrooms.
- 209 Vegetable and Bush Fruits.
- 211 Breakfast foods.
- 212 Seed Testing for Farmers.
- 213-214 (One volume) Small fruits for 1904. Tomatoes and potatoes.
- 215 Experiments with Sugar Beets in 1903.
- 216 Review of Special Bulletins Nos. 24, 25 and 26.
- 217 Fertilizer Analysis (1904.)
- 218 Some essential soil changes produced by micro-organisms.
- 219 Soil moisture. Its importance and management.
- 220 Dried beet pulp and Dried Molasses-beet-pulp for fattening sheep.

BULLETIN 223

JANUARY, 1905

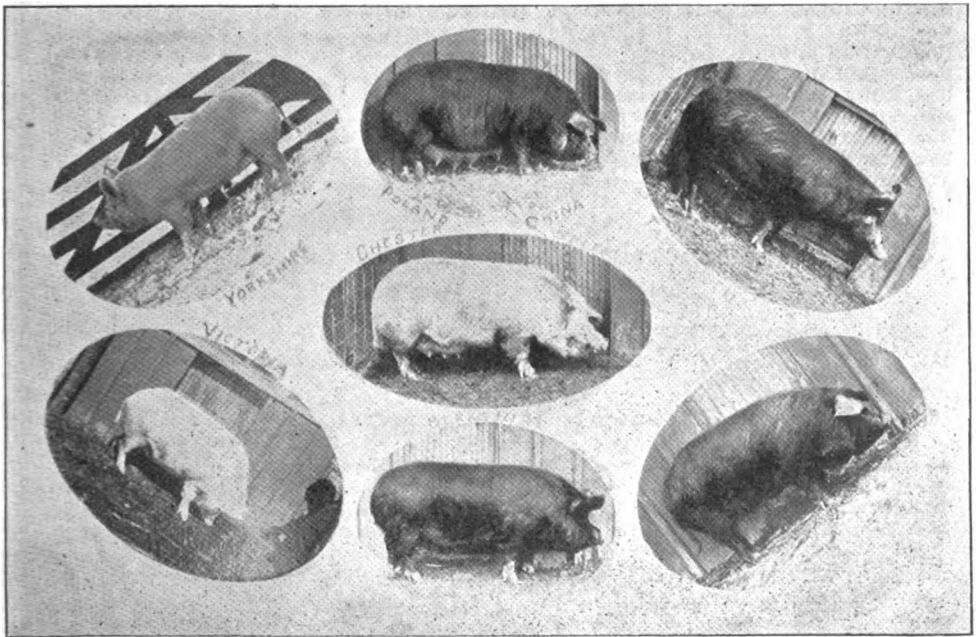
MICHIGAN

STATE AGRICULTURAL COLLEGE



EXPERIMENT STATION

FARM DEPARTMENT



PART I

Equipment for Breeding, Feeding, Care and Management of Swine

PART II

Preliminary Report on Forage Crops for Swine

BY ROBERT S. SHAW.

**AGRICULTURAL COLLEGE, MICHIGAN
1905.**

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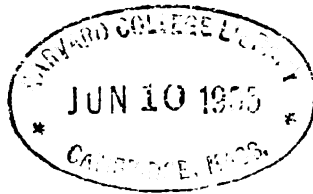
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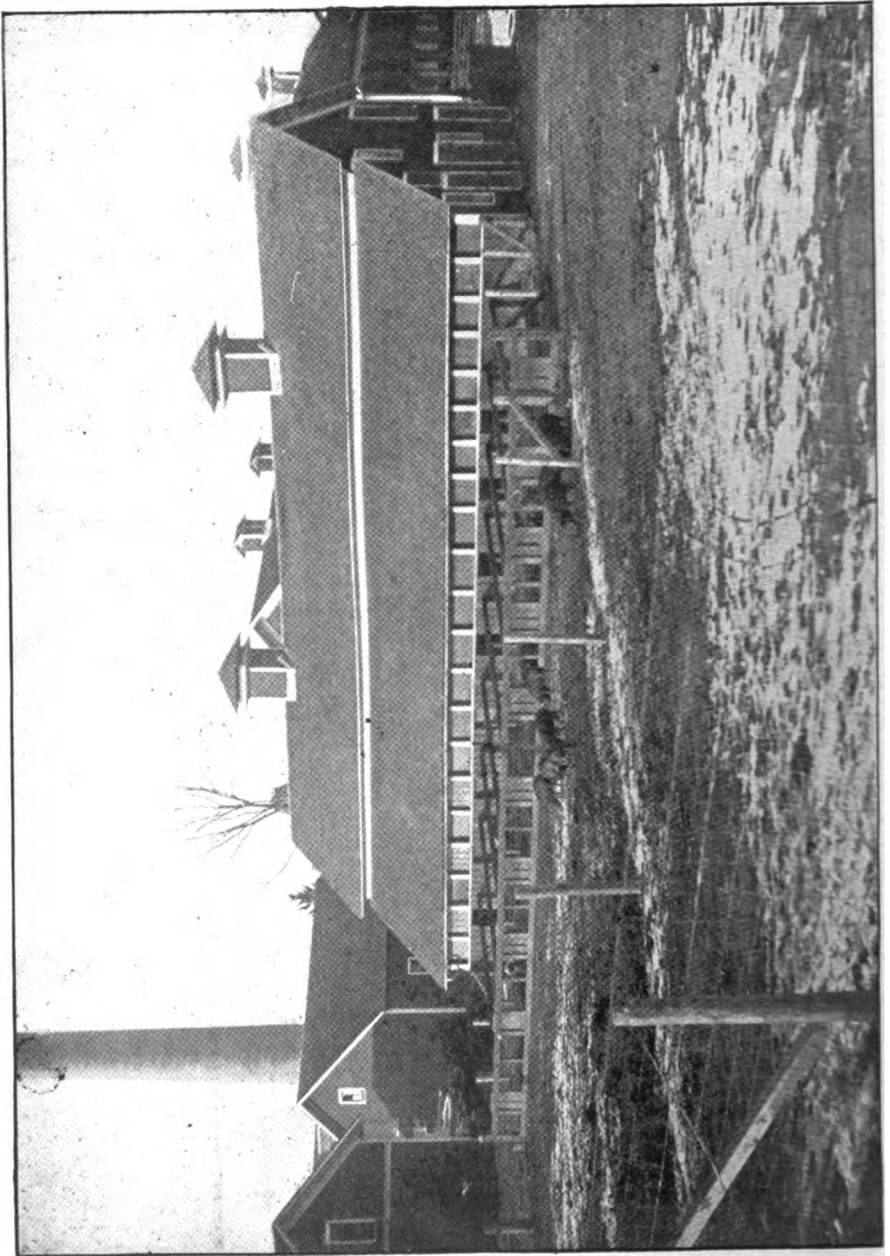
SUB-STATIONS

Grayling, Crawford County, 80 acres deeded. Abandoned.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County 160 acres deeded



Office Station.

This publication consists of two parts. Part I contains illustrations and descriptive matter relating to the equipment recently installed, and now in use at the Michigan Agricultural College for the breeding, feeding, care and management of swine. Part II consists of illustrations and descriptive matter relating to the production of forage crops for swine, the methods employed in growing them, the manner in which they are utilized and the results secured from their use.



PART I.

EQUIPMENT OF SWINE DIVISION INCLUDING BUILDING, COTS, YARDS, FENCES, ETC.

The Building.—*Fig. 1* represents the ground plan of the College piggery as it is now fitted for use. The building itself was among the first erected at the institution for housing live stock and was constructed almost solely by student labor. It is a very old building but, nevertheless, today it contains some excellent material in almost perfect state of preservation. The excellent pine siding and the oak posts, studs, joists, rafters, sheathing and lining, bespeak of days when these materials were plentiful and so inexpensive that nothing but the choicest was used even in the construction of a piggery. The quality and value of these materials, combined with the necessity for making the best use of the material at hand, were some of the conditions requiring the refitting of the old rather than the erection of a new building. In planning and constructing a new building there should be nothing to interfere with the development of the most perfectly desirable plans; in refitting an old building conditions are sure to arise to thwart the execution of desired plans or changes. It is also possible to figure very closely on the cost of erecting a new building while estimates on reconstruction, or refitting, seldom fail to fall short owing largely to the inability to determine exactly what material must be replaced, particularly that which is covered up.

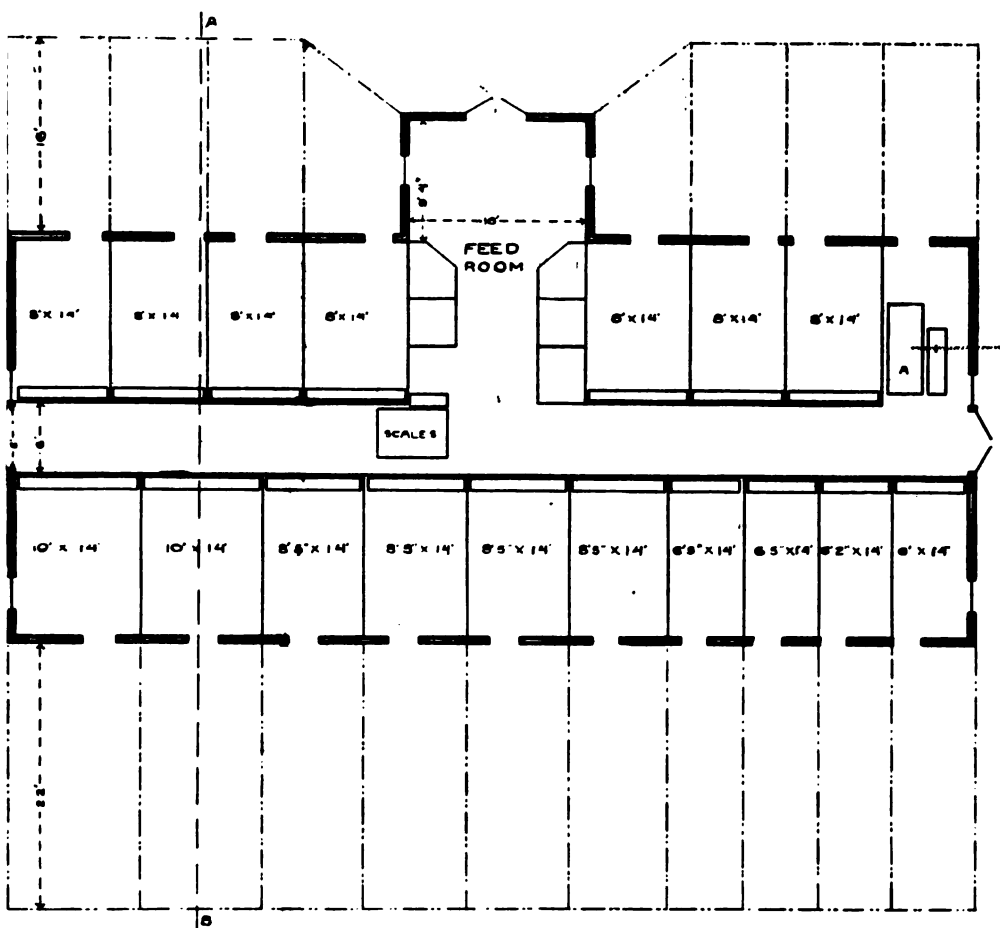
We do not present these plans desiring our readers to accept them as models for the Michigan swine raiser, for the conditions at the college are very different from those surrounding the average breeder or pork producer. While few private individuals keep more than one breed of hogs, the College is maintaining no less than seven distinct breeds for a double purpose. The primary object in keeping so many breeds is to furnish plenty of good specimens to give our students an opportunity to study, in the most practical way, the breed type and characteristics of each breed; the secondary object is to furnish stocks of desirable types for experimental breeding and feeding purposes. At present we have nine pens of experimental feeder hogs comprising fifty-two head. The number of breeds enumerated, requiring the maintenance of several boars, and the numerous lots of experimental and breeding pigs, demand a structure with a large number of pens. The plan of the remodeled building and added equipment are therefore presented, not as models, but with the hope that here and there suggestions of value may be thrown out.

During the past few years there has been a marked increase in the advocacy and use of cots for sheltering swine during the entire year. On first thought our plans may seem to oppose this method but such is not the case. We are using all the pens in this building and also a dozen cots

in yards during the entire year, the former for boars, young pigs and experimental feeders and the latter for brood sows and young animals being grown for breeders. Both methods have their merits and demerits, but we are becoming convinced that under Michigan conditions, with our rigorous winters, a combination of piggery and cots is more desirable for the swine grower than either alone.

The ground plan in *Fig. 1* shows the form of the original building 34x80 feet, consisting of a main structure 24x80 feet with a lean-to 10x80 feet on the south side. Originally this building was fitted with a passageway 8 feet wide all the way across the north side. The remainder of the enclosed space was divided into ten pens of various widths extending from the passage way on the north to the south wall of the building. These long narrow divisions were divided in the center forming inner and outer pens; the former were used for feeding and sleeping quarters and the latter as sort of covered sheds. By this arrangement with the pens proper running down through the center of the building, there was no possibility of sunlight ever reaching the sleeping apartments. According to the present plan the building is divided the long way through the center by an alley 6 feet wide, thus leaving 14 feet of pen space on each side which is an ideal length for pens. The pens on the north side of the building are used for boars and the more mature feeder hogs, while those on the south, admitting an abundance of sunlight, are used by pigs, younger feeders, and to a limited extent by brood sows and their litters. Each pen has access to yardage enclosed with woven wire except the partitions between the boar yards which are constructed of boards; the outer ends of the boar pens are, however, enclosed with woven wire. The yards are the same width as the pens within and are 16 feet long on the north side of the building and 22 feet on the south side. A pair of platform scales is located in the alley at the feed room having been set down in the cement flush with the floor; this is one of the most necessary and most used conveniences about the equipment. There are many who prefer that a piggery cut through the center by an alley with pens on both sides, should be placed on a north and south line in order to admit sunshine on one side in the forenoon and on the other in the afternoon. Many of the simplest, most useful and most inexpensive piggeries are long narrow buildings with but one row of pens; in the use of this form of piggery the pens should invariably face the south.

Cross Section of Piggery.—*Fig 2* shows a cross section of the piggery at the section line indicated by A B in *Fig. 1*. The foundation, as shown by the illustration, consists of the stone wall originally placed under the building. Had it been necessary to replace this foundation, concrete would have been used, being easier to build and less costly. The piers on both sides of the alley supporting the posts, are constructed of concrete. The entire floor is made of concrete, and is four inches thick; the lower three inches consist of coarse gravel seven parts and cement one; the upper inch, or top-dressing, consists of sharp sand three parts and cement one. The alley running through the center of the building its entire length, is six feet wide; this width rather than being a waste of space, is one of the greatest conveniences about the building. An alley placed along one side of a long narrow building need not be so wide but should not be less than four and one-half feet in the clear. Feeding alleys are almost invariably made too narrow. The six-foot alley shown in the illustration is crowned over, being one-half inch higher in the center to insure its being kept perfectly



M.A.C. PIGGERY.
SCALE 1"=16'
A = DIPPING VAT.

FIG. 1.

dry, and was given a rough finish to prevent animals from slipping while being driven to and from the weigh scales. A rough finish can be given by brushing the cement lightly with a steel broom after it has been laid and troweled down. The floors of the pens were given a fall of two inches from the alley to the outer doors, but this is not as necessary as was first supposed, the urine being completely absorbed when the pens are cleaned and bedded as frequently as they should be. We consider some fall to the floors desirable but not more than has been given in this instance; the fall is necessary when the pens have to be flushed out and the whole house given a thorough cleaning and disinfection. Pen floors should also be given a rough finish.

The partitions are constructed of one and a quarter inch oak boards, the material used for similar purposes in the original fittings. The boards were cut into three foot lengths and placed in an upright position, the bottom ends resting on a two-by-four and the tops capped with similar material. The two-by-fours were not guttered to receive the ends of the upright boards as this would make it difficult to replace one should repairs be needed; the ends of the partition boards are held in place by inch strips nailed on the two-by-fours on both sides. When partition boards are placed on end with the wood fibre in a vertical position, hogs cannot gnaw them so easily as when they are placed in a horizontal position. The partitions are raised three inches above the cement floor to prevent them from rotting quickly and to permit of thorough disinfection and the maintenance of good sanitary conditions. The raised sill may become dry and can be disinfected, the one on the floor cannot. The objection to the raised sill is that pigs will work manure underneath it and care must be taken to remove this when the pens are cleaned. In order to prevent manure from accumulating under these sills, we are planning to fill this space with concrete by first tacking a board on one side and then filling the space with concrete held tightly in place by a board tacked on the other side until dry. We feel sure that this will remain in place and can be done much more easily than at the time of the floor construction. The two-by-fours forming the partition sills are fastened to posts at each end and are supported between by two pieces of gas pipe set in the cement and resting in holes bored in the wood of the two-by-four above. The top of the partition need not be more than three feet six inches above the floor. With the possible exception of the boar, a hog that requires higher fencing than this is an undesirable one to have.

The yards on the north side of the building where the boars are kept during a part of the season, are separated by board fences, this being the only safe material for the divisions between them; the ends of these pens are, however, enclosed with woven wire. On the south side the pens are constructed of woven wire, the method of construction being fully described later in this publication. On the north side of the building, the slope of the ground was such that the desired fall could not be given the yards but on the south side a fall of a little more than a foot was established in the twenty-two feet of length, giving most excellent results. The possibilities for securing a good fall in every direction from the piggery should be one of the most important factors in determining its location. Wallows in pig yards, containing the drainings from the manure pile, putrid water and other filth, are prolific breeders and distributors of disease. On both sides of the building strips of concrete three feet wide, were laid next to the walls. This has served an excellent purpose in preventing the hogs

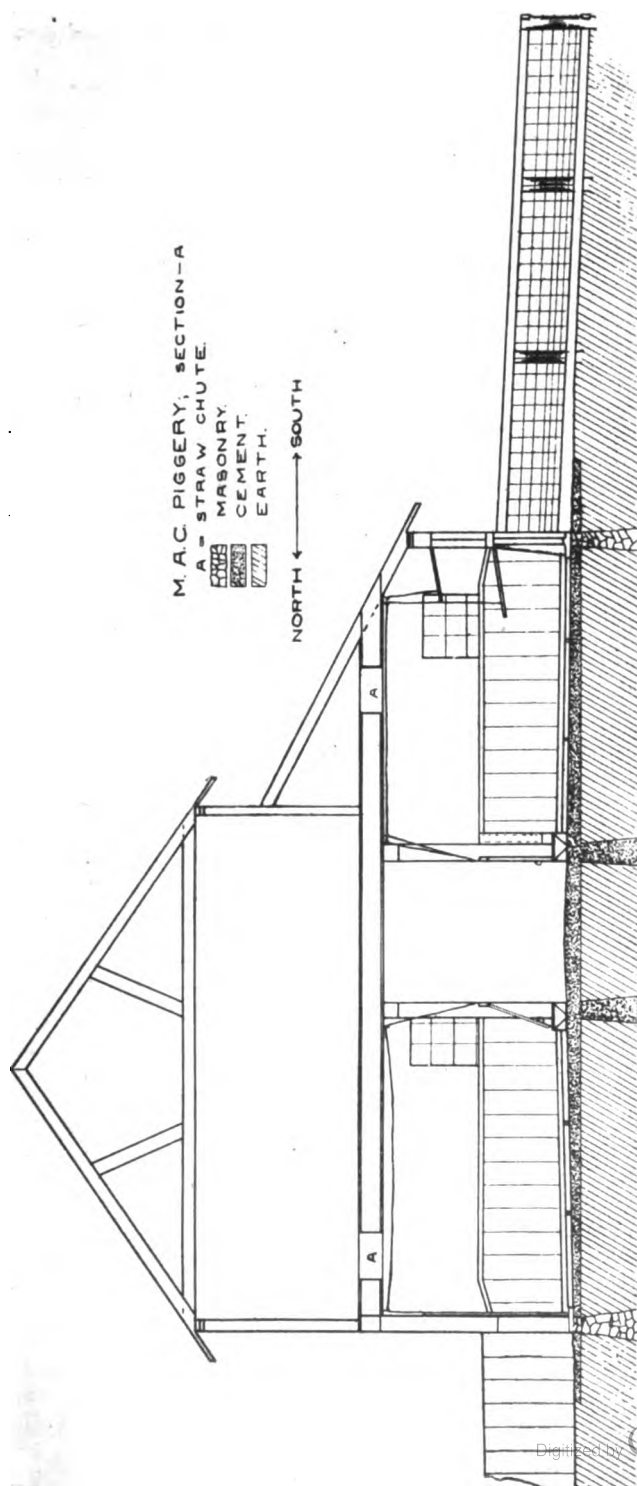


FIG. 2.

from rooting holes and forming wallows against the foundations, thus injuring them.

The loft above is about eight feet high at the posts and furnishes an abundance of room for storage of straw, crates, crate materials, overlays, troughs, etc. No meal feed is stored in the loft. In general food stuffs stored in piggery lofts are continually exposed to extremely impure, foul smelling air.

A system of ventilation was started but still remains incomplete. In this piggery there is an average of one door, one window, and one trap above, for each pen. The traps above are seldom shut and the doors are sufficiently loose to swing. With all these openings we have not yet found an insufficient circulation of air.

This illustration also shows the ropes and pulleys by which both doors and ventilators are opened and closed from the central alley, there being no doors opening into the pens from the alley. The openings A A from the loft show how the bedding is supplied to the pens.

The Pens and Their Fittings.—Reference to Fig. 1 shows the pens to vary from six to ten feet in width. It also shows that the doors opening into the yards are not all regularly located either in the center or corners of the pens. This is due to the fact that the original openings were utilized and could not be readjusted without completely reconstructing the south side of the building. The doors of all pig pens should be located in one corner; there are two reasons for this, in the first place, if placed in the corner most remote from the direction of the prevailing wind, greater protection is afforded the pigs in the pen when the door is open, and second it allows the proper construction of overlays.

Overlays.—What they are and the necessity for their use leads to a short, but necessary, discussion of flooring materials. The plank floor which has been so universally used in the past for piggeries, has now become almost impracticable owing to the scarcity of such material and its high cost; the use of hard wood is entirely out of the question and pine floors are short lived. It is almost impossible to construct a wood floor so as to make it water tight and provide good sanitary conditions. Dry earth floors would be ideal for the sleeping quarters for pigs if they could be kept dry and clean. At the present time there is no floor in use in piggeries more desirable or inexpensive, considering durability, than one properly constructed of concrete nor can as good sanitary conditions be maintained by the use of any other. And yet, notwithstanding these good qualities, cement floors are strongly objected to, and justly so too, on the ground that pigs become crippled if required to nest in beds on them during the winter season. Even though an abundance of bedding is used on cement floors, bad results seem to follow just the same. There are few worse places for a brood sow to farrow than on a cement floor. She gathers the small amount of bedding allowed her into a small pile, beds on it and the newly born pigs wriggle off on the bare floor, which being slippery, prevents them from getting on their feet, the cold floor soon exhausts them, and they perish. It was with the object of overcoming these objections to the cement floors that overlays were used.

Figs. 3 and 4 show two pens, each ten by fourteen feet but with two different forms of overlay. Fig. 3 shows an overlay running across the center of the pen; this form was used because of the outer door being in the center of the pen, thus leaving insufficient room for the overlay in the corner. This overlay is in two sections, each two and one-half feet wide

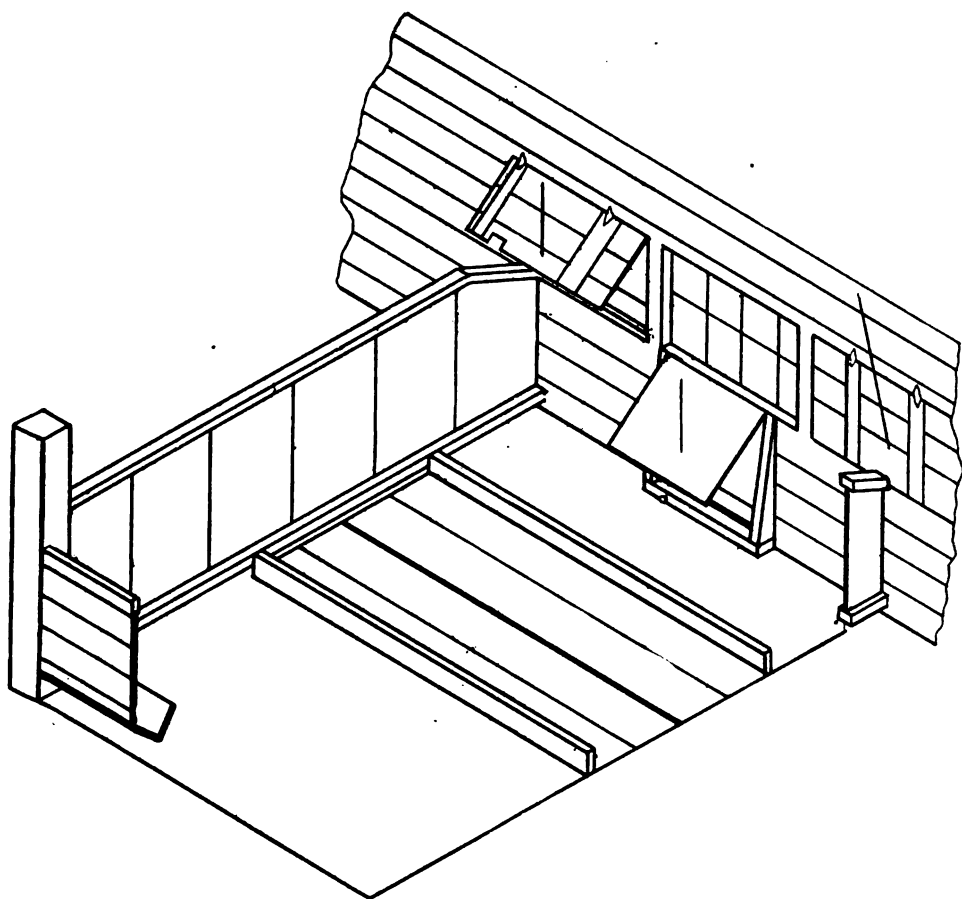


FIG. 3.

so that it can be lifted easily in cleaning out the pen or thrown out in the sun to dry, or put in the loft for storage during the summer. The two sections are held in place by four blocks tacked on the two-by-fours at the bottom of the partitions. This arrangement leaves plenty of room for feeding at the trough and space for the manure near the door. The greatest objection to this form of overlay is that because of its location between the trough and door, the pigs have to cross it frequently, thus not only soiling it but dragging the bed off on the floor as well. This objection is sufficient to urge strongly against this form of overlay. Fig. 4 shows an overlay 6x8 feet in one corner of a pen with the door in the opposite corner.

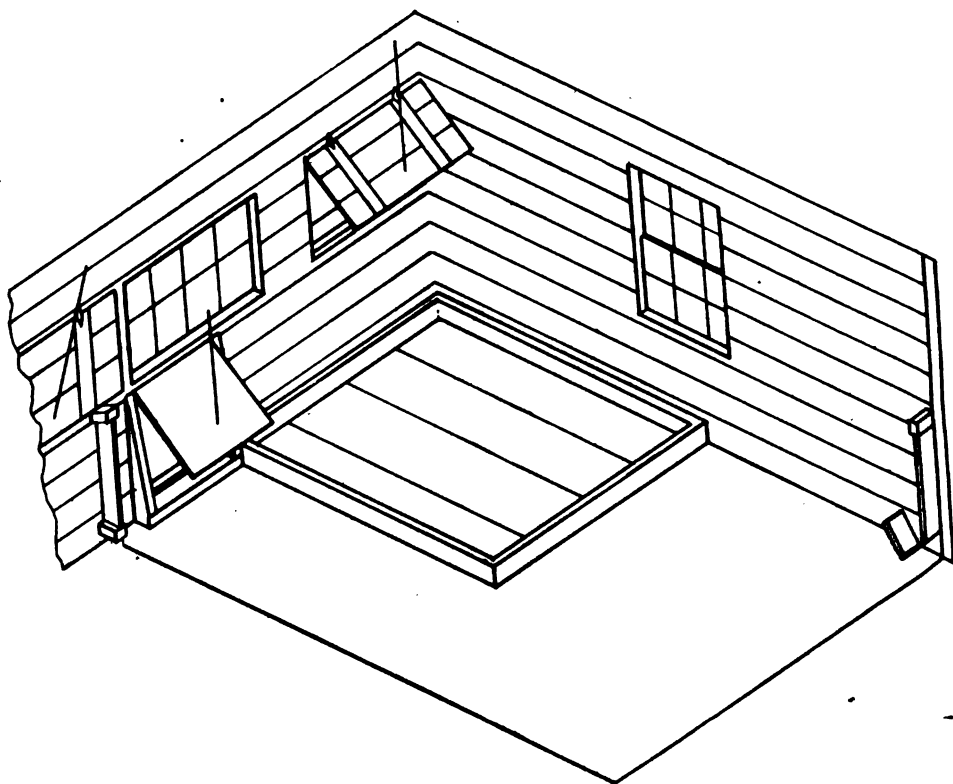


FIG. 4.

This plan is possessed of the advantages of providing more shelter for the bed when the outer door is open and the pigs can go in and out without crossing the bed. The accompanying *Illustration 1* shows nine 180-pound pigs bedded down comfortably on this overlay. This latter form of overlay is hinged to the wall so that when the pen is cleaned out it is tipped up, bedding and all, and any filth which may have accumulated underneath is cleaned out. When the floor is cleaned, the overlay is let down and the bedding thrown off on the floor for absorbent being replaced by fresh straw at least once a week. When the overlay is placed in the corner of the pen, that portion of the floor should be raised somewhat.

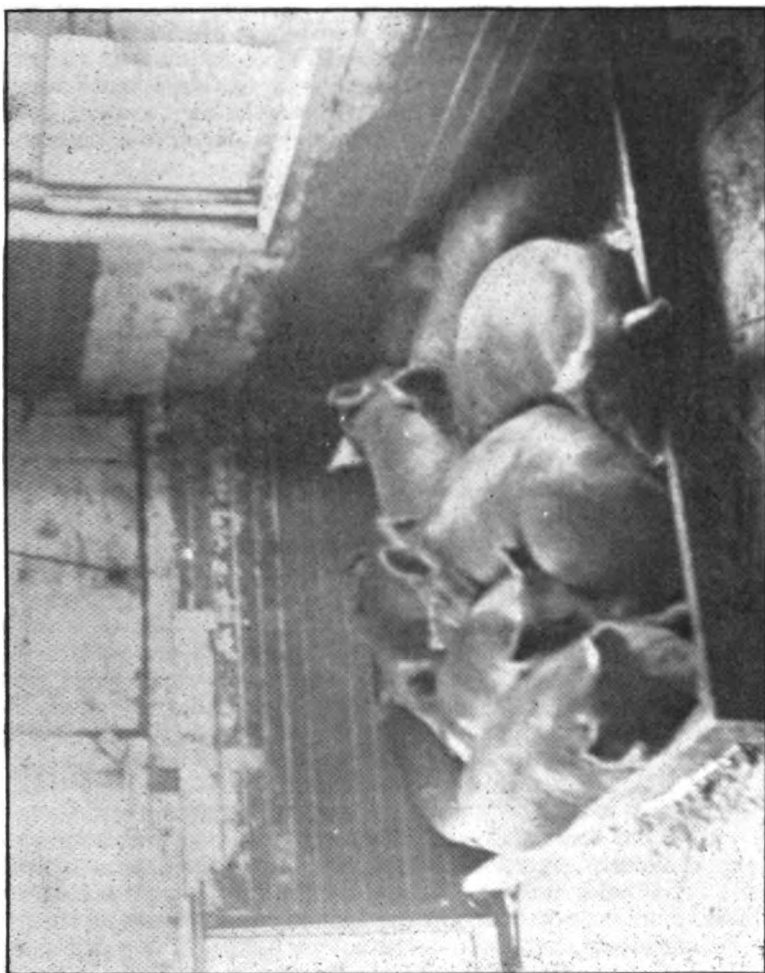


ILLUSTRATION 1.

Both forms of overlay, now in use in the piggery, were constructed from second hand inch lumber; they are raised off the floor by inch cleats which hold the boards together. A two-by-four was set up around the outer edges of the overlay to hold the bedding in place. (A two-by-six may be used.) These were nailed to the boards below and strengthened by triangular pieces of scantling fastened in the angle formed by the two-by-four and the board floor. In the use of these overlays three facts have been strikingly noticeable, viz.: First, pigs invariably use the overlays, by preference, sleeping on the bare boards if there should be no straw on them; second, of the three or four hundred hogs that have been housed in this piggery there are few instances where the bedding on the overlays has been befouled by excreta and the tendency to this is much less in the case of the overlays in the pen corners where the pigs are not trampling over them; third, we have not had a crippled hog in the piggery since

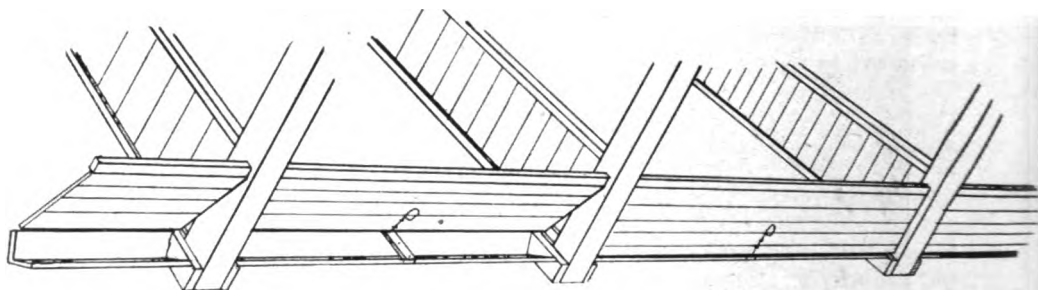


FIG. 5.

these devices have been in use. We dislike the plan of boarding or planking over the entire cement floor surface of a pen during the winter even for farrowing, as dung and urine work in between and under the boards or planks producing very unsanitary conditions.

Figs. 3 and 4 also show one of the two forms of doors used in the piggery. These doors swing inward from the top and are opened from the central alley by a small rope operating over two pulleys as shown in Fig. 2. A light steel rod shaped door spring, fastened to the casing and top of door, forces it shut. Both the door casing and sill are widened by a two-by-six inch boxing which prevents the pigs from getting their noses under the bottom or side of the door to get out. A pig can come in but cannot get out if the door is closed. The only objection to this form of door is that an extremely severe southerly gale pushes them open a little and lets in too much cold; this is prevented by the use of small bolts for emergency cases. On the north side of the building the doors were constructed to slide up and down, but these could not be used on the south side without shutting off some light, the windows being directly over the doors. In addition to a door, each pen on the south side has a window above it and also a hinged panel to one side of the window which may be opened in suitable weather to admit additional sunshine and fresh air.

Troughs.—Fig. 5 shows the feeding troughs with swinging partitions suspended over them in such a way that when swung back the pigs are shut away from the troughs while the feed is being supplied, and when swung forward again in place, they have access to them. This is no new invention for the device, with many modifications, is used in numerous

farmers' piggeries. The only wonder is that it is not more universally used. The top of this swinging partition consists of a two-by-four from which the three-foot partition made of inch boards swings by hinges. This partition is held in place at all times by a half-inch iron rod which slips up and down in staples, being received at the bottom in holes bored in a hardwood cleat nailed across the center of the trough. This fastening prevents the pigs from moving the partition at any time. If the pens are over ten feet in width the swinging partitions are too cumbersome to work well. They should not be made to swing into the pen past the edge of the trough when fastened or the pigs will soon gnaw the edge of the bottom board off. These partitions are made to swing back until they stand straight up overhead resting at the ends between the posts. This permits pigs to be driven out or in, or the cleaning of the pens from the alley. In this case doors connecting the alley and pens were purposely omitted.

The troughs are made of two-inch hemlock constructed in a V shape, one side being two-by-ten inch material and the other side and ends two-by-eight. These troughs are simply toe-nailed in between the division posts so that they can be removed easily and replaced when necessary. We like the V shaped troughs in preference to any flat bottomed sort, in the piggery, because the pigs can clean them more readily and thoroughly and there is practically no contact at the floor except for the short end pieces; as a result filth and moisture do not accumulate beneath them. On the under side of the V shaped trough, next the alley, the floor is always dry and on the pen side it can be cleaned thoroughly and is always exposed to the air. Hemlock troughs last from two to five years, or even longer, particularly if protected by a strip of band iron on the inner edge. Sloppy feed does not chill or freeze in wood troughs as readily as in cement or metal. We like flat bottomed troughs for out door feeding where they are moved about frequently, they are not upset so readily as the V shaped ones. We also like low sided, flat bottomed troughs for weanling pigs.

Hog Cots.—Reference has already been made to the desirability of hog cots in connection with the piggery. When climatic conditions are not too rigorous, cots only are employed for handling the entire herd. In general, the climatic conditions in Michigan are too extreme to permit the use of cots for all classes of hogs for all purposes during the entire year. They are especially desirable, however, for dry brood sows and young males and females being reared for breeding purposes; it is in this way we are using them. They are desirable because an abundance of fresh air, sunshine and exercise are provided. During the summer season coting and yarding nearly all classes of pigs cannot be excelled.

Figs. 6, 7 and 8 represent three forms of cots now in use at the Michigan Agricultural College. Figs. 6 and 7 are forms which have been in use at the institution for some years. The form of cot shown by Fig. 6 is desirable in that it is warm in winter but objectionable in that it provides little protection against the extreme heat of summer. It is also considered a good form of cot for the brood sow to farrow in in moderate weather as she cannot lie down close enough to the sloping roof to crush her pigs as against a wall. A general mistake is made in fastening this form of cot permanently to the skids, or runners, on which it is built. These are the first to decay and along with them the lower ends of the boards, thus making repairs impossible even though the balance of the structure remains sound. A separate pair of skids should be constructed for this or any other form of cot so that they can be replaced. Its own weight will hold the cot in place on the skids while being moved.

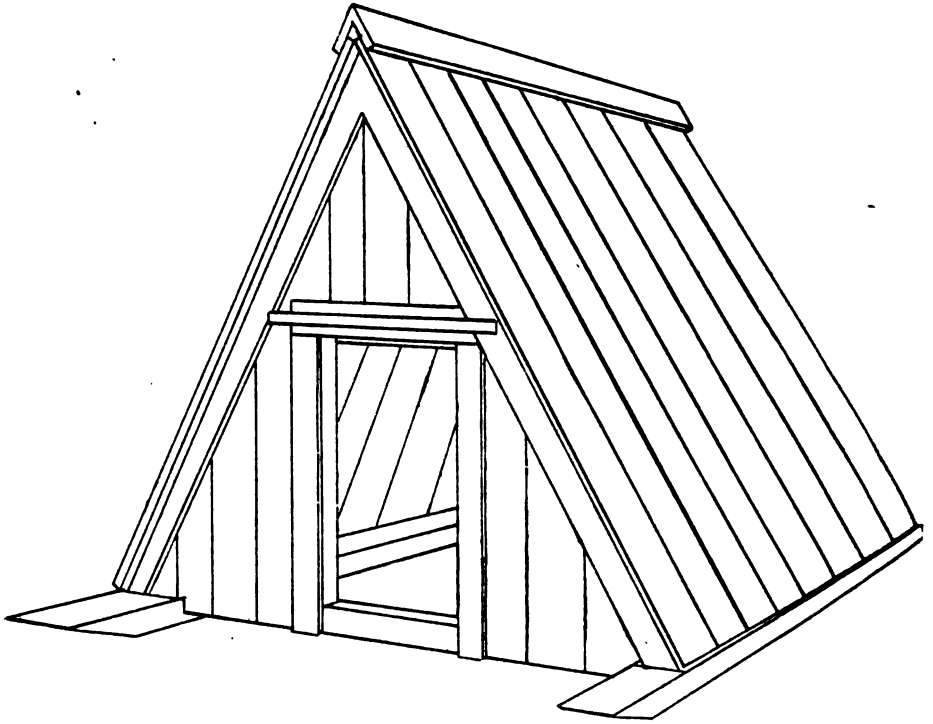


FIG. 6.

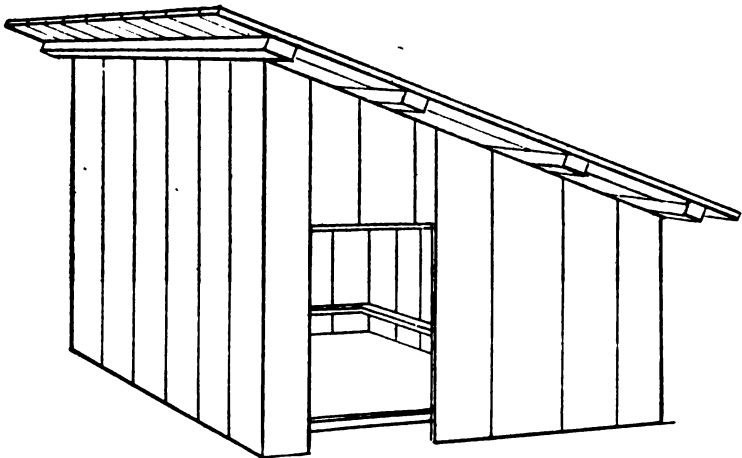


FIG. 7.

Fig. 7 shows a form of hog cot, six by eight feet with perpendicular sides and a flat though slightly sloping roof. This form of cot is made in five separate pieces, the four sides and top, so constructed as to bolt together at the four corners. This form of cot is warm in winter and too warm in summer with its flat top exposed to the sun's rays, and though it may be planned so that the top can be raised in summer, there is trouble from the wind occasionally unroofing it. It is also objectionable in that the sections are too heavy for one man to move and as a result it is not moved as frequently as hog cots should be. All cots should be furnished with skids so that they can be moved frequently by a team and one man and not taken to pieces and moved in sections.

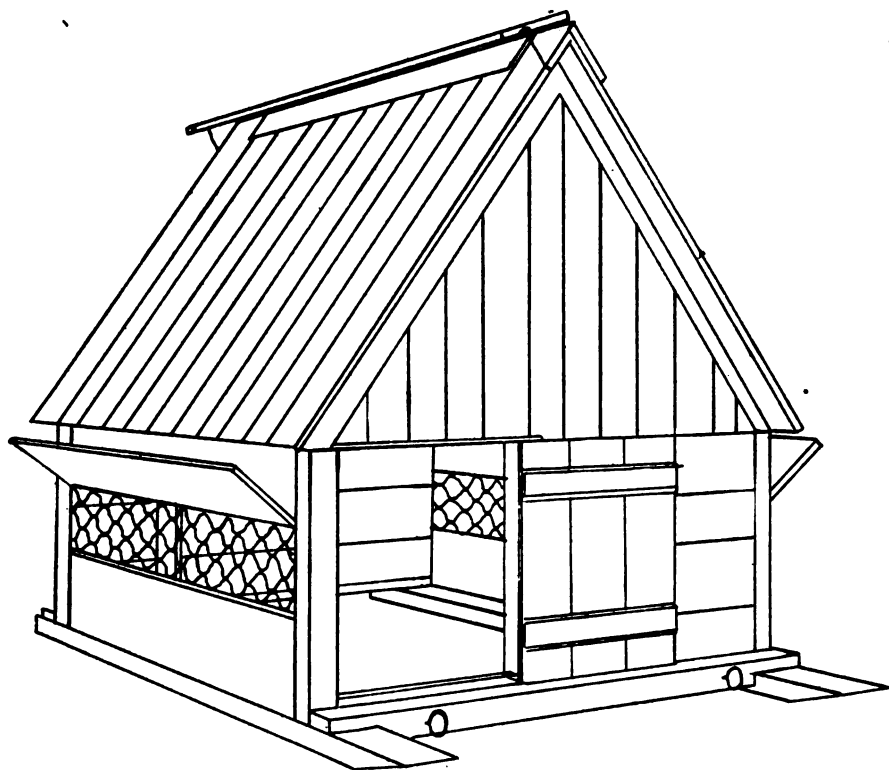


FIG. 8.

Fig. 8 represents a form of cot recently designed and constructed and now in use in our hog lots. It is six by eight feet at the foundation with the sides raised perpendicularly three feet before receiving the half pitch roof boards. The center boards on the sides are hinged so that they can be swung open in hot weather; the opening thus made is covered with strong woven wire, clamped above and below between inch boards; the inner clamp boards project an inch beyond the outer ones, thus breaking the joints and preventing any draught when the openings are closed. The two ridge boards are also hinged so that they can be opened during hot

weather. These openings permit a free circulation of air which not only lowers the temperature but greatly relieves the oppression of the pigs seeking shelter. These openings close down tightly leaving warm quarters during the coldest weather. The cots proper are supported on skids to which they are not attached, being held in place by the blocking of the ties across both ends. A two-inch bottom is used or not, as desired; this flooring is cut in lengths to fit crosswise and rest on the skids which are wider than the sills. This form of cot is not desirable for the farrowing sow without the addition of a railing around the perpendicular walls a few inches from the floor to prevent her from overlaying her pigs. Probably the chief objection to this structure is the expense of material and cost of construction. It contains 160 feet stock lumber, 60 feet matched, 20 feet four-by-six, 12 feet four-by-four, and 44 feet two-by-four and required two days labor in construction.

Yard Fences.—The question of cheap, durable, and serviceable fencing for the small yards adjacent to the piggery is an important problem. During the past, lumber in various forms has been converted into fences of different styles for this purpose, but now its scarcity and high price renders its use almost prohibitive. A tight board fence probably makes the most perfect one for turning hogs. We have attempted to make a suitable substitute, in large part, for the lumber except in the case of the divisions between the boar pens. The fences forming our small pens are constructed of woven wire with two-by-six inch material at bottom and top. The plan is shown in *Fig. 9*. Cedar posts are placed, in this case, a little less than eight feet apart. (They should not be more than this distance for pen fences.) The posts were notched out at the bottom and top one-inch deep and the width of the two-by-six. Thus, the two-by-sixes when firmly spiked in place, instead of being flush, projected an inch out from the surface of the post. The 26-inch woven wire was placed on the posts with top and bottom wires just touching the two-by-sixes. The woven wire was not stapled to the end posts but each strand brought around the post and wrapped on itself. The wire fencing was also stapled to the intermediate cedar posts and the top and bottom wires to the two-by-sixes against which they rested.

The woven wire used was special hog fence with seven lateral wires, top and bottom wires No. 9 and intermediate No. 12. There are twenty-eight No. 11 cross wires to the rod. The woven wire and two-by-sixes make the fence thirty-eight inches high. This has furnished a cheap fence and after three seasons' use we are perfectly satisfied with it. But one repair has been made and that at a point where a flaw occurred in the wire. The openings of these pens consist of doors which slide up and down in grooves at the sides, dropping into slots at the bottom to prevent pigs from opening them.

Lot Fencing.—The term lot is here used to designate larger enclosures, such as those furnishing pasture and forage crops. In pursuing economic methods of swine husbandry, pasture and forage crops are essential throughout the greatest possible portion of the year. Few crops provide continuous pasturage throughout the growing season and even those which do may require resting spells for recuperation. Continuous pasturing and foraging by hogs is largely dependent on a succession of these two classes of crops. As a small area can be made to produce sufficient green crop for large numbers of hogs, this fact, in addition to the two already stated, would seem to require either a number of small lots or one large one sub-

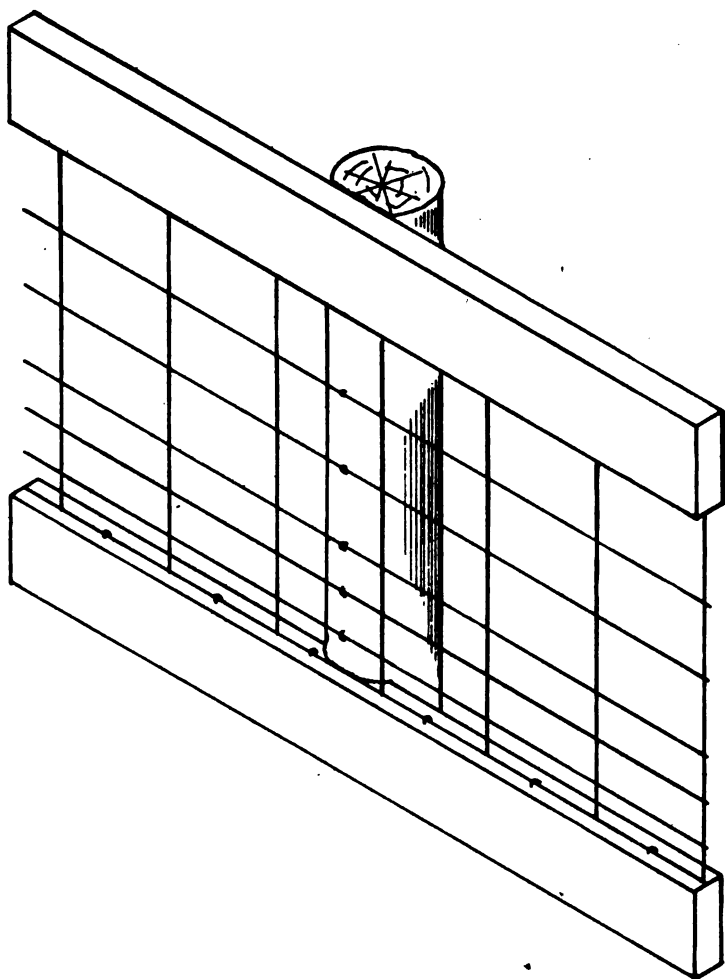


FIG. 9.

divided by portable fences or hurdles. Portable fences constructed of light lumber have been commonly used in the past but this material is no longer practicable under general conditions. If the number of hogs on a farm will justify the growing of say six acres of forage crops, this should be enclosed and divided through the center by permanent fences. Division of the two halves can then be made by means of a portable woven wire fence as follows: Set a row of posts two rods apart across each half for the support of the portable fence; owing to the distance between the posts they will not interfere seriously with cultivation. *Fig. 10* shows a contrivance devised for the attachment of a portable woven wire fence at the ends. Two posts cleated together at both top and bottom about four inches apart, are set in line with the fence at each end. If the woven wire is stapled to the end posts firmly enough to hold it, the fence will be badly damaged in withdrawing the staples to remove it, so that it would soon

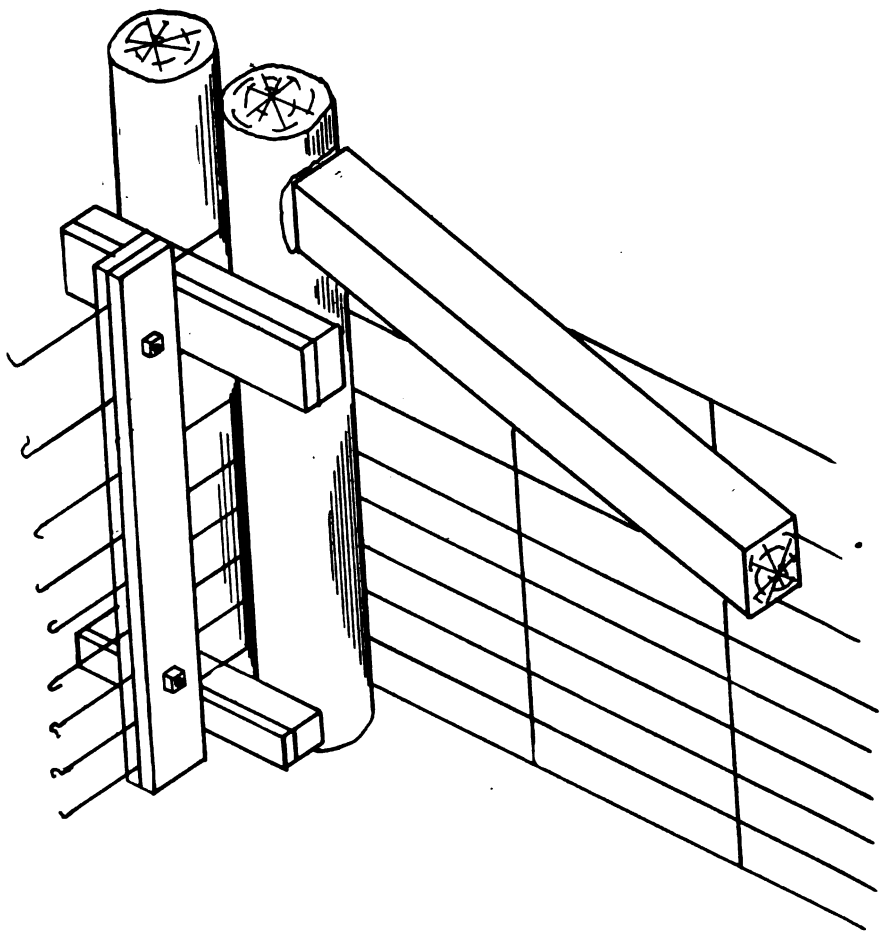


FIG. 10.

be destroyed. In order to overcome this difficulty, we bolt two pieces of one-by-four inch oak on the fence in the form of clamps placing these clamps one on each side of an upright wire to prevent slipping of the laterals. This is then drawn through between the two posts at one end and blocked by two-by-fours. A wire stretcher is then attached to the other end; the fence is pulled up tight; the end drawn through between the end posts and clamps and blocks used as heretofore described. The stretcher can then be slacked back and removed. The wire fence is held in an upright position against the intermediate posts by staples only partly driven. It required but two hours to release, move and again set up 358 feet of fence this way. In some cases it may be necessary to pin the fence down between the posts but the occasion for this seldom occurs till the feed becomes too short. Occasionally sags will occur in the ground where pins would be lifted by the tension of the wire. In such cases the fence can be held down in the following manner, viz.: Wrap a short piece of wire around a rock, bury this underneath the fence and fasten the bottom strand of

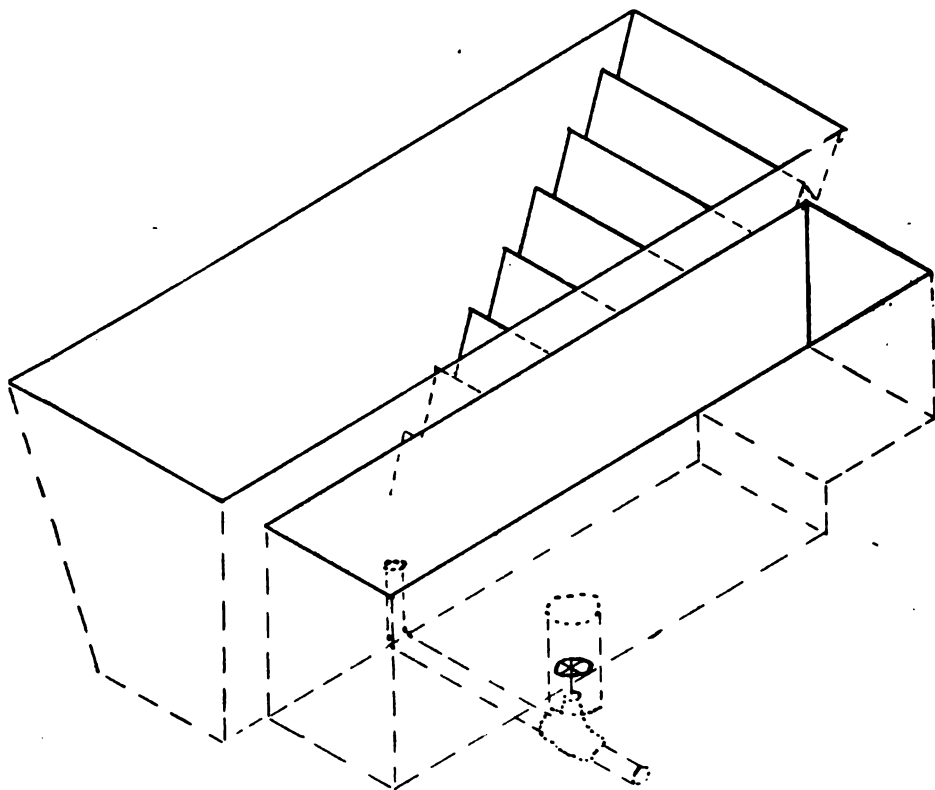


FIG. 11.

the fence down to the wires which project above ground from the rock. For portable fencing we have used thirty-inch woven wire which seems to be plenty high enough. A strand of barbed wire affords effective restraint when placed underneath a woven wire fence and is particularly desirable beneath permanent ones.

The Dipping Vat.—Fig. 11 represents the form of dipping vat in use in the piggery, the location of which is shown in Fig. 1. This vat is constructed entirely of concrete. It is three feet deep, seven feet six inches long on top and three feet six inches long on bottom. It is eighteen inches wide on the bottom and thirty at the top. The end next the passageway is perpendicular, requiring the animals to plunge in; the other end is sloping with creases in the cement forming little steps to enable sheep and hogs to walk out. Adjacent to the vat and separated from it by an eight-inch cement partition, is a dry chamber five and one-half feet long, two and one-half feet deep, and eighteen inches wide, for an attendant to stand in and hold or handle sheep, as the vat is used for both sheep and hog dipping. One end of this chamber is raised nearly a foot to enable the attendant to assist sheep up the incline. The cement floor around the vat is so graded that the drippings are returned to it. This illustration shows, also, the drain pipe leading to an underdrain with the valve in the dry chamber below the floor level of this part. This vat was easily constructed, inexpensive, durable, and is entirely satisfactory.

PART II.

FORAGE CROPS FOR SWINE.

Fig. 12 represents the arrangement of the lots for swine. In 1903, lot 1 produced rape, lot 2 succotash, lot 3 peas and oats, and lot 4 sugar beets; in 1904, lot 1 produced succotash, lot 2 peas and oats, lot 3 sugar beets and mangolds and lot 4 rape. No. 5 is a permanent June grass pasture and No. 6 furnishes yardage for sows and young pigs housed in the brooder house C. No. 7 grew cow peas, soy beans and carrots in 1903 and rape in 1904. The lots numbered 8, 9, 10, 11, and 12 are used almost exclusively for yardage for exercise.

The permanent fences surrounding this area consist of forty-eight and fifty-eight inch woven wire; the inner divisions vary from thirty to thirty-six inches as heretofore described. The gates are ten and twelve feet in width, wide enough to permit the passage of a team and the necessary implements of tillage, as well as the movement of hog cots. The gates A A and B B are hung to overlap so as to turn hogs either one of two ways without inconvenience. This arrangement of lots permits of the production of a variety of forage crops and the carrying out of a very intensive system. Such minute subdivision and the growth of all the varieties we are using, may not be necessary under the average farmer's conditions. We desire it to be emphatically understood that this report of forage experiments is merely preliminary. It is the purpose to continue these lines of work until unquestionable results have been secured.

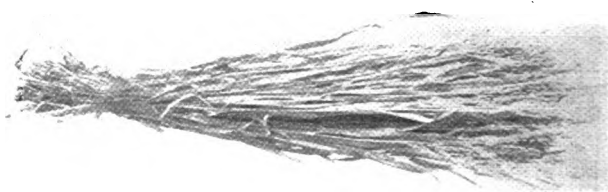
Succotash for Swine 1903 and 1904.—In 1903 lot No. 2 Fig. 12, was sown to a succotash mixture on May 8th; the ground was spring plowed. This mixture consisted of corn 1 peck, peas 1 peck, oats 1 peck, and barley 6 quarts. The mixture was sown by an ordinary grain drill at the rate of $2\frac{1}{2}$ bushels per acre. This crop was not pastured off by hogs as intended, owing to inability to finish the necessary fencing before the succotash got too large to pasture. It was cut and weighed immediately after the time of cutting, between June 24th and July 6th, yielding 7,629 pounds of green fodder from the one-third acre. At this rate one acre would have yielded 22,887 pounds, or 11.44 tons. The growth was dense and tall; all the grains showed well except corn, which was from poor seed.

In 1904, lot 1 Fig. 12, was sown to a succotash mixture, differing slightly from the previous year; this crop was sown May 7th and was preceded by rape in 1903. In this case the mixture consisted of corn, oats, peas, rape and millet sowed in the following manner. After the ground had been prepared for seeding, a mixture of millet and rape, equal parts, was sown broadcast on the land by hand using a pint of each to the one-third acre. The corn, oats and peas in equal parts by measure, were then mixed and sowed by a grain drill at the usual depth, the same operation covering the rape and millet lightly. All the plants of this mixture made a good

Pea.



Oats.



Corn.



Rape.



Millet.



ILLUSTRATION 2.

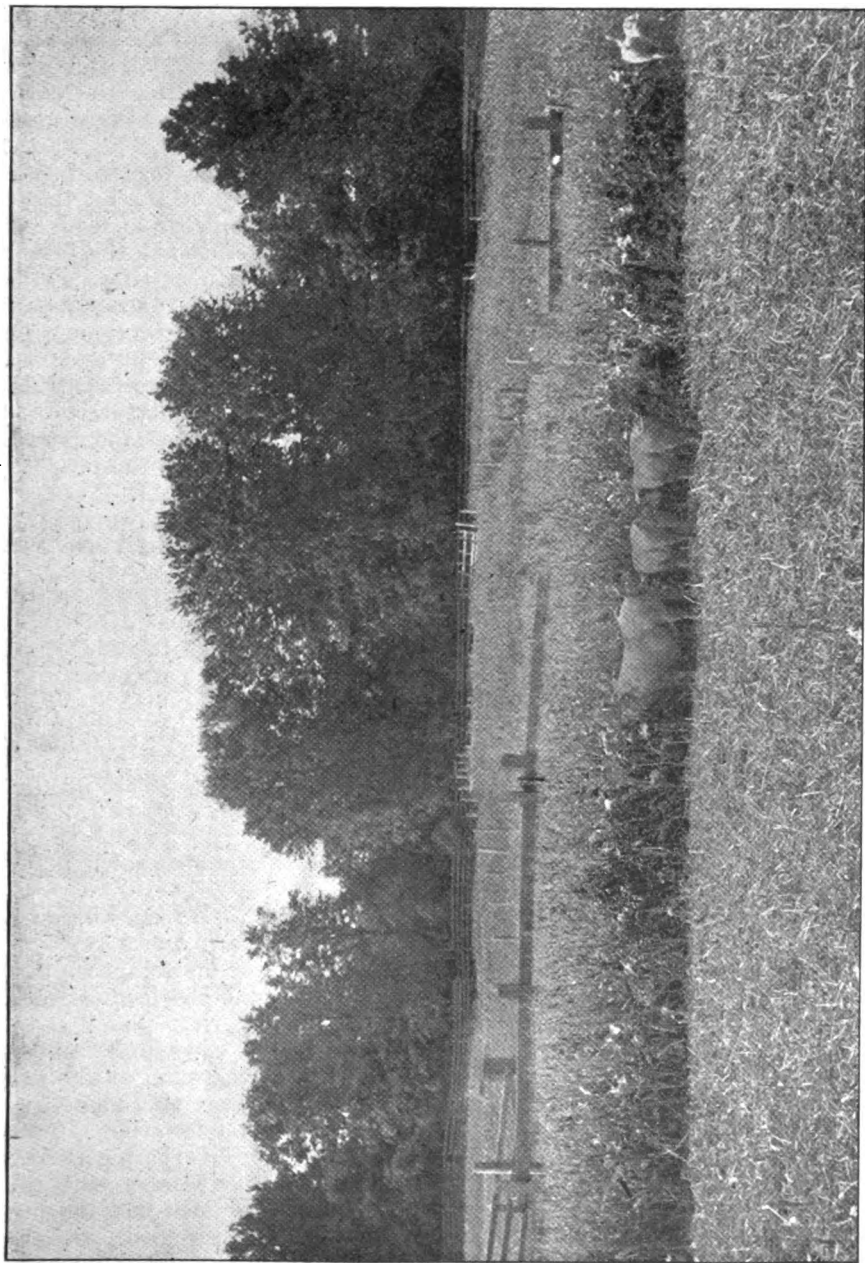


ILLUSTRATION 3

even start except the millet which grew slowly, but some soon outdistanced the others. *Illustration 2* shows the relative size and proportions in which these five plants grew in the mixture. The plants were secured by cutting out two or three small areas, representative of the lot, and then separating out the plants of the various sorts which were photographed for this illustration. These samples were taken July 12th, at which time the entire crop averaged three feet in height, but many of the pea vines were much longer than this.

This lot of succotash was foraged off by sixteen young pigs turned in on June 20th, at a weight of 1,208 pounds; they foraged on the lot thirty-two days, receiving at the same time some supplementary grain food. *Illustration No. 3* shows some of the pigs foraging. As this was the first of a series of experiments with three different classes of hogs, the detailed results will be given later. Where this crop was grazed off, the rape plants were bitten off so close to the ground that they failed to grow again. On another lot, however, grown in exactly the same way but cut and used as a soiling crop for dairy cows, the rape made a second growth which some six or eight weeks later was about knee high. This mixture proved to be an excellent one for dairy cows; the small amount of rape present in first cutting, did not appear to effect the milk at all, while the peas furnished considerable of the much needed protein.

Through the courtesy of F. W. Robison, Station Chemist, we received the following results of the analysis of the 1904 succotash mixture with the results expressed on "dry air" samples as follows, viz.:

Moisture.....	8.30%
Ash.....	10.35%
Protein (total nitrogen).....	15.09%
Proteids (true).....	14.30%
Amido bodies.....	.79%
Ether extract.....	5.45%
Crude fiber.....	27.01%
Carbohydrates (not fiber).....	33.8%

The sample analyzed consisted of the remixed materials shown in the illustration No. 2.

Peas and Oats as Forage for Swine, 1903 and 1904.—In some localities peas are quite commonly grown until they nearly reach maturity, when hogs are turned in to feed upon the grain and such of the forage as they may desire. Our tests of 1903 and 1904, to determine the feeding value of this forage crop for hogs, gave the following results, viz.:

Test of 1903.—On May 9th, 1903, lot 3 Fig. 12 was sown to a mixture consisting of peas three parts, and oats one part, by measure, at the rate of 2½ bushels per acre, a seed drill being used. Oats were used along with the peas to hold them up off the ground and prevent mildew. On August 14, 1903, when the peas were just past the cooking stage, seven pigs weighing 780 pounds were turned in the lot to forage. By September 10th, the peas, most of the oats and some forage, had been consumed and the pigs had received no other food though water was regularly supplied. On this date the hogs were removed at a weight of 850 pounds. This one-third acre of peas and oats, therefore maintained 780 pounds live hogs 27 days and produced a gain of 70 pounds. At this rate one acre would maintain 2,340 pounds live hogs 27 days and produce 210 pounds pork.

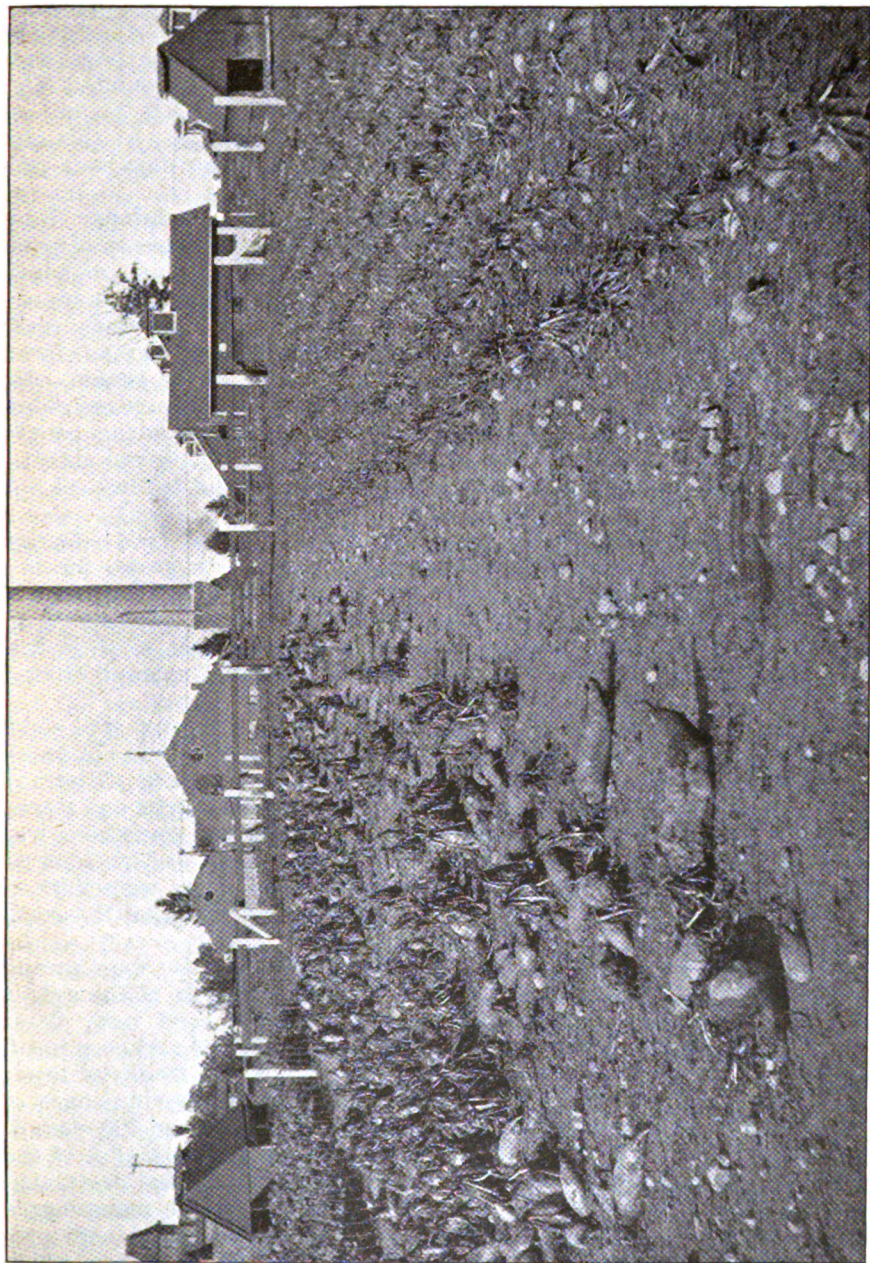


ILLUSTRATION 4.

Test of 1904.—In a manner like unto that just described, peas and oats were grown in lot 2 Fig. 12, in 1904, which had produced succotash in 1903. The mixture was sown May 7, 1904, and seven hogs weighing 1,321 pounds were turned in August 4th with the grains at about the same stage as the preceding year. On August 17th, after thirteen days, these hogs were removed weighing 1,376.5 pounds, making a gain of 55.5 pounds. This one-third acre of peas and oats, therefore, maintained 1,321 pounds of live hogs thirteen days and produced a gain of 55.5 pounds. At this rate one acre would maintain 3,963 pounds live hogs thirteen days and produce 166.5 pounds gain.

These two tests were conducted under exactly the same conditions. Both years the growth of pea vines was excessively heavy at the expense of grain production, due, largely, to the exceeding richness of the soil on which the crop was grown, and the very wet season. Some of the oats were apparently smothered but sufficient grew to hold the peas up fairly well; these oats matured and were not quite all gleaned by the pigs as shown by the appearance of a vigorous volunteer crop later in the season. No peas were left, however. These results in pounds of pork are considerably less than we should expect from an acre of peas, producing twenty bushels of grain and the small gain is no doubt due to the soil and climatic conditions which stimulated vine and leaf growth at the expense of the grain.

Sugar Beets and Mangolds as Forage for Hogs 1903 and 1904.—During the past two years, sugar beets and mangolds have been grown for hog forage, the plan followed being to turn the hogs into the lots early in the fall and allow them to do their own harvesting. Some supplementary grain was fed while the pigs were consuming roots because of their inability to consume sufficient of these to get the required amount of dry matter.

Test of 1903.—Lot No. 4 Fig. 12, previously used as a hog run, was sown to sugar beets May 12, 1903. This lot was spring plowed and did not break up good and a portion was water-logged late into the season. After the ground was prepared, it was marked off into rows two feet apart and sowed with a hand garden drill; the time required for these two operations was two hours time of one man. The crop was hand wheel hoed as soon as it came up and as often thereafter as necessary. The roots were thinned to eight inches in the row and grew to a much larger size than those desired for factory use.

On September 29th, sixteen hogs weighing 2,049 pounds, were turned in upon the sugar beets. These were removed November 7th, at the weight of 2,633 pounds, having gained 584 pounds. During these forty days however, 350 pounds middlings and 1,205 pounds middlings and corn meal, equal parts, was fed to these hogs. According to W. A. Henry's "Feeds and Feeding" the meal fed would nearly account for the maintenance of these hogs, 1.88 pounds of meal being supplied each day per 100 pounds live weight, or the 1,555 pounds meal fed would account for 345½ lbs. of the increase and part of the maintenance, allowing 4½ pounds meal per pound gain. And the sugar beets would account for a part of the maintenance and the production of 238.5 pounds pork. Thus, if one-third acre produced a gain of 238.5 pounds, one acre would produce 715.5 pounds, which valued at 5 cents would equal \$37.77, return from one acre of beets in the form of pig feed.

Test of 1904.—On May 7, 1904, lot No. 3, Fig. 12, which has produced peas and oats in 1903, was sown to sugar beets and mangolds, there being eleven rows of each. This crop was cultivated in about the same manner as that grown the previous year. In order to get at least some idea of the relative yields of the mangolds and sugar beets, the two adjacent rows of each were pulled, topped and both roots' and tops weighed the day before the experiment began; these were afterward thrown back to the pigs. These two rows of roots were 308 feet long and the distance between them was two feet. The row of mangolds weighed 1,060 pounds and their tops 430 pounds, which estimated gives 37.4 tons roots and 15.2 tons tops per acre. The one row of sugar beets weighed 560 pounds and their tops 510 pounds; the estimates from these figures give 19.7 tons beets and 18 tons tops per acre. We recall the fact that these lots, which had been hog yards for years previous, were very rich, the conditions being especially conducive to the growth of tops.

On October 3d, twelve cross-bred hogs weighing 1,329.75 pounds, and four pure breds weighing 438.5 pounds, making a total of 1,778.25 pounds, were turned in upon the roots where they remained till December 12th. The ground, of course, froze up before this but the then remaining roots were pulled, piled and covered so that the hogs still had access to all they could eat. On December 12th, the twelve cross-bred hogs weighed 1,840.5 pounds, and the four pure breds 537 pounds. (The light gain of the four was due, in some measure, to the uncongenial spirit manifested them by the twelve.) In 70 days, therefore, these hogs gained 598.25 pounds, but 752 pounds middlings and 752 pounds corn meal had also been fed them during this time, or about one and one-fifths pounds meal mixture per day to each one hundred pounds live weight of hogs turned in the lot, or about one-third grain ration daily. Allowing $4\frac{1}{2}$ pounds meal for maintenance and the production of one pound pork, the 1,504 pounds meal would be responsible for 334.2 pounds of the gain; this would leave a part of the maintenance and the production of 246 pounds of pork to the credit of one-third acre of roots, or 792 pounds pork per acre, worth at 5 cents, \$39.60. In this last experiment the proportion of meal furnished to the live weight of the hogs was less than in the first case.

It was observed that the pigs consumed the mangolds first, as shown by *Illustration No. 4*; it may have been because they could be secured more readily. Owing to the fact that the mangolds stood up high out of the ground, they were soon tipped over and left exposed to the sun during the day and the frosts at night; for this reason and the fact that sugar beets are less easily damaged by frost, it is fortunate that the mangolds were consumed first. Pigs scour considerably when turned in on roots in this way unless considerable dry feed is given the first few days. Butcher hogs come off this kind of feed paunchy and require three or four weeks grain feeding to fit them for market. This method should bring breeding stocks into winter conditions in strong vigorous shape. The pigs will dig all roots out even to the very tips, unless the ground freezes. We did not use sufficient hogs in these tests, nor turn them in quite early enough.

Maintenance of Brood Sows on June Grass and Rape, 1904.—It is now generally conceded that it is very desirable to keep brood sows on pasture and forage crops as much as possible during the growing season. There are two reasons why this practice is desirable; in the first place it is the cheapest food of maintenance, and in the second place, the exercise re-

quired to secure the food and the fresh air and sunshine. are conducive to physical conditions favorable to the production of litters of strong, vigorous pigs. Owing, however, to the bulkiness and watery condition of these foods, care should be taken to supply, in addition, some substantial grain foods or mill by-products, as the period of pregnancy advances. The following very satisfactory results have been secured from the maintenance of brood sows on June grass followed by rape.

WEIGHTS OF FIVE DRY SOWS DURING TEST OF 105 DAYS.

	Weight May 27, 1904.	Weight July 9, 1904.	Weight July 25, 1904.	Weight Aug. 6, 1904.	Weight Sept. 9, 1904.	Gain or loss.
Poland China.....	298	283	281	183	291.5	-6.5
Old Tamworth.....	366	358	359	353	379.5	+13.5
Poland China No. 1.....	194	180	173.5	176	180	-14
Poland China No. 2.....	159	171	163	177	174	+15
Poland China No. 3.....	170	163	155	157.5	164	-6

These five sows were turned on June grass May 27, 1904, rape July 9th, June grass again July 25th, and returned to rape August 6th, where they remained till September 9th, in all covering a period of 105 days. No grain or supplementary feed of any sort was given during the entire period, though the sows had access to water and shade. During these 105 days there was an increase of two pounds in the weight of the bunch. Owing to the smallness of this gain the only inference we can make is that June grass and rape provide only for the maintenance of these animals. The shortness and dryness of the June grass toward the end of the period, ending July 9th, accounts for the slight shrinkage at that time.

MICHIGAN



STATE AGRICULTURAL COLLEGE
EXPERIMENT STATION

OBSERVATIONS ON THE
INFLUENCE OF NODULES ON THE ROOTS UPON THE COMPO-
SITION OF SOY BEANS AND COWPEAS

BY
C. D. SMITH, AND F. W. ROBISON

AGRICULTURAL COLLEGE MICHIGAN
1905

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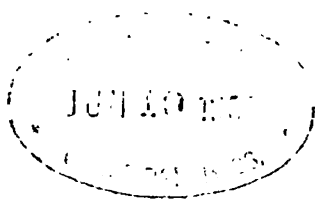
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 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.



The Station

OBSERVATIONS ON THE INFLUENCE OF NODULES ON THE ROOTS UPON THE COMPOSITION OF SOY BEANS AND COWPEAS.

BY C. D. SMITH AND F. W. ROBISON

INTRODUCTION.

The appearance of the very timely article on "Bacteria and the Nitrogen Problem" in the year book of the Department of Agriculture for 1902, page 333, and of Bulletin No. 71 of the Bureau of Plant Industry, entitled "Soil Inoculation for Legumes," has placed in the hands of the farmer somewhat full information as to the present knowledge of the significance of nodules on the roots of legumes. It is not the purpose of this bulletin to discuss the micro-organisms involved in the production of these nodules nor to treat of inoculation of seed and soil. That phase of the subject is left to another department of the station. This bulletin is designed to put on record the results of certain investigations made on the station plots, as to the influence of nodules upon the appearance of the growing crops and upon the quantity and quality of the harvest. The bulletin reports progress and not conclusions.

I. THE INFLUENCE OF THE NODULES ON THE ROOTS UPON THE APPEARANCE OF THE PLANTS.

The notes upon the station plots for three years record a great many occasions upon which a very decided difference in color and thrift could be noted between plants in the same plot. Some of the plants would be dark in color and rather more thrifty in general appearance than others. In the case of soy beans where limited areas were thus noted, examinations were made of the roots. In no case could the difference in color be ascribed to the presence of nodules. On a certain series of plots, marked G on the station map, a very conspicuous instance of this kind occurred. A certain area with well defined margins was conspicuous for its dark green color. About it the plants were of a light color. An examination of more than a dozen plants in the dark colored area, failed to disclose the presence of nodules.

A field of soy beans was growing in another part of the station grounds when a similar small area of dark colored leaves was noted. Here, as in the other case, there was no relation between the color and the presence of the nodules. In this case the plants were inoculated but the number of nodules was no greater per plant where the color was dark than where the color was light nor were the nodules larger.

On several occasions equal areas were sown to soy beans and cow peas, one area inoculated and with nodules on the roots, the other

area not inoculated. As far as quantity of crop is concerned the results have not shown a large and notable increase due to inoculation.

II. THE INFLUENCE OF THE PRESENCE OF NODULES ON THE COMPOSITION.

On the 23d of September, 1903, there were growing on the station plots, two areas of soy beans. On one of them the roots were practically free from nodules, on the other the roots were well inoculated and nearly covered by them. The variety of beans was the Medium Green, a late sort ripening its seed but rarely and in favorable seasons only, but affording an abundance of leaves and stems. On the date mentioned, the pods were well formed but the seeds hardly more than well started and much less than half grown.

The seed had been sown in rows eighteen inches apart. From one of the rows, which, in appearance, fairly represented the plot, there was measured off eight feet in length. An area eighteen inches wide, with the row in the middle and eight feet long was left standing while the earth about it was removed to the depth of eight inches. The plants in this eight feet of row were then carefully removed, the dirt being washed away by a gentle stream of water. Each rootlet was thus saved and the entire weight of the plants in the eight feet of row, or twelve square feet of ground, was determined. The total yield of the twelve square feet, including roots, stems and leaves, was then taken to the laboratory, the roots separated from the stems at the point where the mower knife would have cut at harvest and the weights of roots, nodules, and stems and leaves separately taken.

Exactly the same thing was done with a row of soy beans having no nodules. The stems and leaves weighed 5.125 pounds from the area with nodules and 5.562 pounds from the area without nodules. The roots of the beans with nodules weighed but .438 pounds and of those without nodules .625 pounds. The nodules weighed but .16 pounds.

In the early spring of 1904 ground was prepared for a repetition of the work of 1903. After plowing and harrowing two plots were laid off, each a square rod in area. Upon one of them there was applied a wheelbarrow load of soil from a field which had borne soy beans for several years with roots well covered with nodules. The other plot was left without inoculation. As the season advanced, examination showed the roots of the soy beans on the inoculated area to be well covered with nodules while the roots on the area not inoculated remained free from them.

The variety was again the Medium Green. The seed was good and the stand perfect or nearly so. During the growing season no difference was noted in the growth of the two plots, nor in the color of the foliage. The soil was fairly fertile. It had borne sugar beets the year previous and clover the year before that, receiving a coat of barnyard manure upon the clover sod.

On the first of September, eight feet of row was taken from each plot for comparison. As in 1903, the roots were taken for nine inches on each side of the row and to a depth of eight inches. The dirt was carefully removed and all the rootlets and nodules saved. There were 52 plants, weighing 4 lbs. 5 oz. on the eight feet of inoculated row; 49 plants weighing 3 lbs. 12 oz. on the eight feet of uninoculated row.

The roots and nodules weighed 9 oz. inoculated and the roots but 6 oz. from the uninoculated plants.

The next table gives the chemical composition of the dry matter of the several parts of the plants mentioned.

COMPOSITION OF DRY MATTER OF SOY BEANS, WITH AND WITHOUT NODULES.

With nodules, leaves and stems.	Ash.	Protein.	Nitrogen.	Phosphoric acid.	Potash.
1903.....	8.86	18.53	2.97	.55	1.98
1904.....	8.79	16.23	2.60	.65	2.23
Mean.....	8.825	17.38	2.785	.60	2.105
Without nodules, leaves and stems.					
1903.....	8.04	9.56	1.53	.57	1.76
1904.....	10.25	12.60	2.01	.65	2.17
Mean.....	9.15	11.08	1.77	.61	1.965
With nodules, roots (nodules removed).					
1903.....	6.58	6.92	1.11	.35	.87
1904.....	7.14	5.72	.91	.40	1.29
Mean.....	6.86	6.32	1.01	.375	1.08
Without nodules, roots.					
1903.....	4.74	11.31	1.81	.30	.44
1904.....	12.08	6.60	1.05	.39	1.27
Mean.....	8.41	8.955	1.43	.345	.855

In 1904 a similar investigation was carried forward with cowpeas. The results are inserted here before comments on the foregoing table are made.

COMPOSITION OF THE DRY MATTER OF COWPEAS WITH AND WITHOUT NODULES ON THE ROOTS.

Leaves and stems.	Ash.	Protein.	Nitrogen.	Phosphoric acid.	Potash.
With nodules.....	14.39	22.50	3.60	.71	2.47
Without nodules.....	13.42	15.22	2.43	.84	1.67
Roots.					
With nodules.....	5.38	5.61	.89	.62	1.32
Without nodules.....	8.57	12.34	1.97	.61	2.53

COMMENTS ON THE TABLES.

The attention is first directed, naturally to the relative amounts of protein in the forage of the inoculated and not inoculated plants. The leaves and stems together of the inoculated soys carry 17.38 pounds of

protein per hundred weight while the not inoculated have but 11.08 pounds per hundred weight as the mean of the two years. Note that in both years the per cent of protein was higher with the inoculated and that when both years are taken together the content of protein was 56.86 per cent greater in the inoculated plants.

With the cowpeas the inoculated plot was 47 per cent richer in protein than the one with plants free from nodules on the roots.

The importance of this fact is apparent. While little difference could be detected between the several plots during the growing season, either in color or general thrift, the chemist found a wide variation in the values of the harvests as to either feeding or manurial constituents. If the presence of the nodules insures no greater yield of these legumes on a fairly fertile soil, if the farmer reaps no heavier harvest where the nodules are, he may expect a richer harvest, better alike for his cattle and his soil.

It is notable that the roots of the uninoculated plot are richer in protein than those of the inoculated. The nodules were removed, of course, from the roots of the inoculated specimens. These nodules have the following composition:—Protein, 26.19 per cent; Nitrogen, 4.19 per cent; Potash, 2.05. The nodules of Cowpeas were analyzed separately and were found to be made up as follows:—Protein, 24.39 per cent; Nitrogen, 3.90 per cent; Phosphoric acid, .96 per cent.

As to why the roots of the uninoculated legumes contain a greater per cent of nitrogen than those of the inoculated, the answer is not obvious. It may be that the material furnished by the germs in the nodules is more quickly carried by osmosis through the cell walls and therefore sooner transferred to the growing parts of the plants.

In the following table there is given the grams of dry matter in the leaves, stems and roots of inoculated and not inoculated soy beans and in inoculated and not inoculated cowpeas. In the columns following there is given the composition of this dry matter in per cents:

COMPOSITION OF DRY MATTER OF LEAVES, STEMS AND ROOTS.

	Dry matter, grams.	Protein, %	True proteids, %	Amids, %	Ash, %	Nitro- gen, %	Phos- phoric acid, %	Potash, %	Yield of nitro- gen per acre, lbs.
Soy beans, inoculated.									
Leaves.....	205.98	22.71	18.44	4.27	11.26	3.63	.72	2.27	113.55
Stems.....	284.37	11.54	5.81	5.73	7.02	1.85	.60	2.21	
Roots.....	55.2	5.72	5.23	.47	7.14	.91	.40	1.23	
Not inoculated.									
Leaves.....	198.92	17.89	13.77	4.12	13.86	2.96	.65	2.29	75.98
Stems.....	247.48	8.35	5.28	3.07	7.36	1.33	.68	2.07	
Roots.....	49.00	6.00	5.41	1.19	12.08	1.05	.39	1.27	
Cowpeas, inoculated.									
Leaves.....	220.61	27.08	22.59	4.49	16.38	4.33	.71	1.63	139.21
Stems.....	220.21	17.93	11.11	6.82	12.40	2.87	.65	3.32	
Roots.....	171.15	5.61	4.94	.67	5.38	.89	.62	1.32	
Not inoculated.									
Leaves.....	238.41	21.52	17.93	.....	18.30	3.48	.87	1.20	118.45
Stems.....	315.44	10.47	.....	.....	9.73	1.67	.83	2.04	
Roots.....	62.75	12.34	7.58	.....	8.57	1.97	.61	2.83	

The first column, in the above table, reports the weight of the dry matter of the yields of 12 square feet. The weights are given in grams. Because it is unsafe to calculate acre yields from areas so small as 12 square feet, two adjacent plots of soy beans were harvested at about the date of the taking of these samples for analysis. One of these plots contain .8 of an acre, the other 1.29 acres. The former yielded at the rate of 3517.6 lbs of dry substance per acre and the latter 4214 lbs. Calculating the yield of dry matter per acre from the figures given in the table above we have 3924 lbs. as the yield per acre of dry matter of the inoculated plot and 3572 lbs. for the uninoculated. These amounts are midway between the actual yield of the larger plots. For this reason it is evidently safe to calculate the yield of nitrogen per acre from the factors given in the table. This has been done and in the last column of the table is found the calculated yield of nitrogen per acre expressed in pounds. The yield of the inoculated soy beans is 113.55 lbs. of nitrogen per acre. These figures include not only the leaves, stems and roots as stated in the table but the nitrogen in the nodules on those roots. Unfortunately the weights of the nodules on the roots of the cowpeas was not taken and the 139.21 lbs. includes no nitrogen resident in the abundant nodules.

It is interesting to note that the inoculation has increased the amount of nitrogen in the soy beans almost exactly 50 per cent. It is not yet demonstrated that the 37.57 lbs. of nitrogen found in the inoculated soy beans more than in the uninoculated comes entirely from the air through the intervention of the nodules nor is it known that the 37.57 lbs. measures all of the nitrogen taken in by the inhabitants of these nodules. In any event the increased amount of nitrogen returned to the soil by plowing under a crop of inoculated soy beans is amply sufficient to induce every farmer to see that his crop is inoculated if he intends to use it as a soil renovator.

The fact that the per cent of protein is so much greater in both leaves and stems of inoculated soy beans must lead to the determination to inoculate the crop if it is to be cured as hay. It is worthy of note that in the soy beans the increase in protein is mostly in the true proteids and not in the amids. The inoculation does not seem to notably affect the phosphoric acid nor the potash.

What has been said of the soy bean is true of the cowpea. Here, however, the difference in yield of protein per acre is not so wide and significant.

III. THE INFLUENCE OF THE PRESENCE OF NODULES UPON THE COMPOSITION OF THE SEED OF SOY BEANS.

In 1904 some investigations were conducted to test the influence of the nodules on the roots on the composition of the ripened seed of two varieties of soy beans. The Medium Green is not certain to mature its seed in this latitude, but did so in 1904. The Ogemaw is an earlier sort, fairly certain to ripen in an average year. Seed was gathered from each of four plots, two inoculated and two not inoculated and were submitted to the chemist for analysis. The results are set forth in the next table.

Ogemaw.	Moisture, per cent.	Protein, per cent.	True proteids, per cent.	Fats, per cent.	Fiber, per cent.	Other carbohydr- ates, per cent.	Ash, per cent.
Not inoculated.....	8.08	35.39	22.69	15.66	5.18	30.52	5.17
Inoculated.....	8.88	42.20	31.28	13.86	5.20	26.13	4.23
Medium green.							
Not inoculated.....	8.12	31.23	21.46	17.38	5.92	32.22	5.13
Inoculated.....	8.80	36.45	24.51	16.27	5.40	27.96	5.12

FERTILIZER VALUE.

Ogemaw.	Nitrogen, per cent.	Phos- phoric acid, per cent.	Potash, per cent.
Not inoculated.....	5.66	1.72	2.09
Inoculated.....	6.75	1.43	1.55
Medium green.			
Not inoculated.....	5.00	1.78	2.38
Inoculated.....	5.83	1.66	2.43

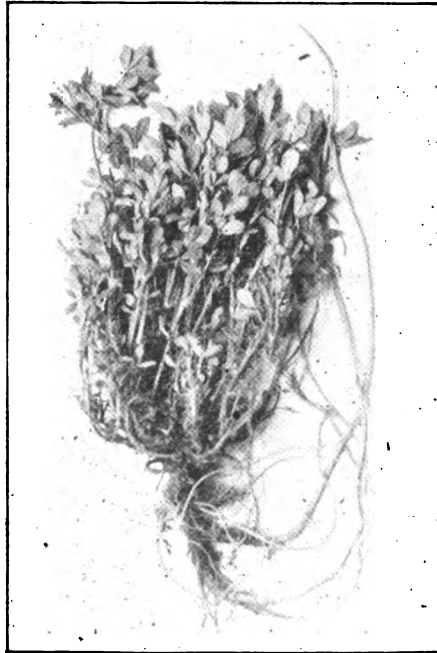
The influence of the nodules had not spent itself on the growing plant, but carried itself throughout the period of growth, making the ripened seeds of the inoculated soy beans fully 16% richer in protein than the product of uninoculated areas.

Whether this increase in protein content will give greater vitality to the seeds affected or cause the growth of a more vigorous crop the next season remains to be investigated.

In conclusion of the work of the two years it has been learned that the nodules on the roots, while, on fairly fertile soil, they may not notably increase the yield, do increase the relative and absolute amount of nitrogen in the plants. This increase is very important and pronounced.

MICHIGAN STATE AGRICULTURAL COLLEGE
EXPERIMENT STATION

FARM DEPARTMENT.



(Typical Alfalfa Plant in Middle May.)

ALFALFA IN MICHIGAN.

By C. D. SMITH.

AGRICULTURAL COLLEGE, MICHIGAN
1905



The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

The Station

MICHIGAN AGRICULTURAL EXPERIMENT STATION

Postoffice and Telegraph Address, - - - Agricultural College, Mich.
Railroad and Express Address, - - - Lansing, Mich.

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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded. Abandoned.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
Chatham, Alger County, 160 acres deeded.

ALFALFA IN MICHIGAN.

C. D. SMITH.

INTRODUCTION.

There were discussions concerning the value of alfalfa to Michigan farmers as early as 1888, when the crop was editorially recommended for trial, especially on the lighter soils of central Michigan and on worn lands in the southern part of the State. Not much was written on the topic, however, and there were few successes recorded. Some correspondents in Eaton, Lenawee and Oakland counties reported trials but usually the winters were found too hard for the crops as they were then handled.

On the other hand the rural press for the last five years has been full of reports of trials of alfalfa under all kinds of conditions, some correspondents reporting success, others failure. Clover has failed occasionally and there has been an earnest effort to secure another forage crop richer still in protein. Alfalfa has succeeded in western United States and has yielded abundant crops of hay rich in protein and very palatable. It is therefore to be expected that it should be extensively tested in Michigan.

The first mention of alfalfa in the publications of the station occurs in the report of Professor Samuel Johnson, Agriculturist, in 1889, page 271 of the Annual Report of the Secretary, 1889. Professor Johnson says: "Plat 2 (one acre) was sown with twenty pounds of alfalfa seed. This came up in one week from the date of sowing and continued to grow, and June 9 covered the ground fairly well. The highest plants were four inches above the ground and the roots extended more than this below the surface. A frost on the night of June 1 injured the alfalfa to quite an extent. The alfalfa was dark green, and until affected by the drouth in July when it turned yellow, made a fair growth; although some of it seemed dead, the roots were not affected, and later in the season it revived and made a fair growth. The alfalfa feeds mainly from the subsoil, and for this reason many fail to get as good results as they look for. It thrives best on an old soil, that which has received deep thorough tilling for some years." The farther history of the field is not given beyond the fact that the crop did not withstand the winter.

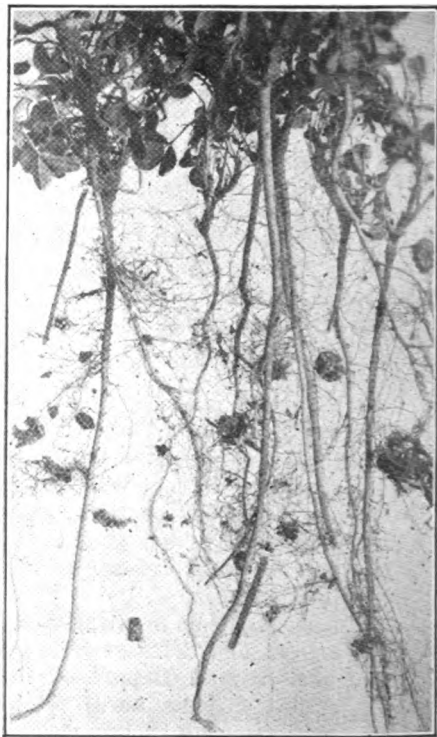
On each succeeding year, small fields of alfalfa have been sown on the college farm or the station plots, studying the adaptation of alfalfa to Michigan conditions. In 1893 and 1894 special efforts were made

to bring this forage crop into prominence because the depredations of the root borer had made the successful growing of clover impossible.

Early in the year 1894 the station issued a brief press bulletin in which alfalfa was recommended for further trial and at the close of the same year Bulletin 125 was issued giving facts in regard to alfalfa with the preliminary statement as to the kind of soil on which it might be expected to do best, and directions for sowing and caring for the growing crop. In 1896 Bulletin 141 was sent out in which the history of alfalfa in Michigan for that year was recounted.



Alfalfa roots showing normal nodules, small and near large roots.



Peculiar nodules on Alfalfa roots, in groups and distant from large roots, on small rootlets.

A two acre field on the south bank of the Red Cedar River was sown to alfalfa in 1895. The soil varied from a stiff clay to a light coarse sand of low fertility. The seed was purchased in the open market and was said to be fresh and American grown. It was sown on well prepared ground at the rate of 20 pounds of seed per acre, in May. The crop survived the winter in good shape and four cuttings were made in 1896, May 28, June 29, August 17, and September 26. The total yield of dry hay per acre was 9,937 pounds. After the last cutting the alfalfa made a good growth and the field was green and very promising. In the spring of 1897, however, not a living alfalfa root could be found on the entire two acres. Although the winter was not extraordinarily severe, and although the field was fairly well covered with snow the destruction of the alfalfa seemed to be complete.

In 1897, not discouraged by former reverses, farther sowings of alfalfa were made. On some very light sand some seed of the variety called sand lucerne was sown. A good catch was secured. The yields of this acre in successive years were as follows: In 1898, 6,800 pounds; 1899, 10,000 pounds; 1900, pastured; 1901, 13,839 pounds; 1902, 12,034 pounds; 1903, 5,820 pounds.

The plot was plowed up in the spring of 1904, June grass having crowded the alfalfa so far that few plants were left.

In the years between 1897 and 1901, alfalfa was sown both on the strip reserved for new and peculiar plants, called the "Curiosity Strip" and on other parts of the station grounds. It was observed that in nearly every case, on a majority of the plants, nodules were present. In no case was artificial inoculation used, nor was soil brought from a former alfalfa field to the new plot. It is possible that the germs were carried on the seed or were already resident in the soil. In 1897, for instance a plot of alfalfa was sown on a distant field, number 14 of the college farm, fully a half mile from any other alfalfa or from any plot that had borne alfalfa for many years, yet the roots were found to be well inoculated and have remained so until date, 1905. In 1904 some clean seed was sown on an area in field 6. In 1903 the field had borne vetches. The crop was not gathered but was allowed to lie on the ground during the winter to be plowed under in the spring of 1904, shortly before the alfalfa was sown. The accompanying cut shows the abundance of the nodules and their peculiar grouping. No artificial inoculation of either seed or soil was used.

A study of the work accomplished with alfalfa and the lessons to be drawn from the many tests on the station plots is reported in this bulletin.

SUMMARY.

I. Alfalfa belongs to the family of legumes, along with clover, peas and beans and therefore may entertain on its roots micro-organisms which have the power of converting the nitrogen of the air into forms which plants can use. For this reason it would be a valuable addition to the list of forage plants in Michigan if it should prove hardy and capable of withstanding the severe winters.

II. The leaves and stems of alfalfa are very rich in protein. The average protein content of the hay gathered in May, June and August was 14.48 per cent, while that of clover hay is not far from 12 per cent. Alfalfa furnishes a first crop ready to harvest, on ordinary seasons, the last of May. Two other crops usually follow, the second in July and the third in late August. For this reason it makes an excellent soiling crop. The yields of dry hay per acre on good soil vary from three to six tons.

III. Alfalfa is peculiarly adapted to arid sections under irrigation. Whether it will become a permanent and valuable crop for Michigan is yet to be determined. It has met with little or no success in New England outside of Vermont, where, out of fifty-six trials, fourteen farmers report failure, twelve permanent success and ten temporary success. In Quebec, Ontario and New York it has succeeded at several points.

IV. The station has distributed alfalfa seed for trial to over one hundred and fifty farmers. The United States government has also distributed seed to many farmers in the State and the records of these plots have been turned over to this station. Of seventy-six reports from farmers who have tried alfalfa, thirty-two record absolute failures, due generally to winter killing; twenty-four record partial success, for a single year; sixteen record success for two or more consecutive years. The chief enemies of the crop in Michigan, after winter killing, are June grass, and dodder. The latter is a parasitic plant introduced with the seed. No alfalfa seed should be sown until approved by the station.

V. Alfalfa seed is expensive and the temptation to adulteration is therefore strong. No seed should be sown until its per cent of germination is determined. The Turkestan variety has given less yields than others but has withstood the winters better. As between the so-called Salauer seed from Utah and Colorado grown, there seems to be but little difference. The variety called sand lucern seems to withstand the winter as well as Turkestan and to give larger yields.

VI. Alfalfa has been sown on all kinds of soil on the station plots and seems to do equally well on the light sand and on well drained clay. It does not do well on undrained land, on soil with a stiff subsoil near the surface, on acid soils nor on muck of the kind on the station grounds.

VII. Alfalfa responds to fertilizers whether barnyard manure or commercial fertilizers. Of the latter those containing lime, phosphoric acid and potash, without nitrogen, seem to be called for.

VIII. The repeated sowings at the college have scarcely recorded an instance where the roots have been free from nodules although no artificial inoculation has been used. The germs giving nitrogen-fixing power seem to have been transferred to the new crop on the seed.

From some parts of the State reports come that nodules are not present. It is therefore prudent to inoculate the seed or soil with the proper germs when sowing.

IX. Prudence dictates that twenty pounds of seed per acre should be used providing the per cent of germination is above eighty. If the seed has a lower per cent of germination, even larger quantities per acre should be sown.

X. The date of sowing depends on the season, the month of May being preferred, in southern Michigan, and possibly the month of August north of the line marking the southern boundary of a permanent snow cover during the winter.

XI. If weeds threaten the tender plants in the first season they should be clipped but the last clipping should not be later than the last week in August.

XII. Although large crops are secured where the alfalfa makes a good stand, hard winters are certain and the crop is not yet entirely beyond the experimental stage in Michigan.

THE INVESTIGATIONS.

SOILS.

Alfalfa has been tried on many varieties of soil from the light blowing sand to the heavy plastic clay and on muck. On the latter the stand has been neither good nor permanent, the crop usually dying off within two years from winter killing combined with injury from frosts. The adaptability to muck has not been sufficiently studied to warrant a final statement. Experiments are now in progress to answer questions on this topic.

On stiff clay the crop made a good growth in 1895 and 1896 but was totally destroyed in the winter of 1896-7. The roots were not short, notwithstanding the stiffness of the clay but extended for distances of five to eight feet into the subsoil, where plenty of water was found.

On a dry gravel bank, alfalfa has made a stand from 1897 to 1905 and is still vigorous although the stand is not thick enough for a profitable crop. A deep excavation has been made at one side of the plot and the roots of the alfalfa discovered at a depth of fourteen feet below the surface, the roots being at that point one-fourth inch in diameter.

On loams of all kinds, some almost pure sand and others approaching the clay, alfalfa has almost invariably made a good start. Severe winters have killed off the plots in almost every case, but loams seem to be the types of soil on which the crop does the best.

On sands that are carried by the wind which therefore are lacking in adhesion and in humus, alfalfa seems to be rather more permanent than elsewhere. Plots sown on such soil in 1897 produced good crops until 1903. It cannot be said therefore that alfalfa is a crop unusually fastidious in the matter of soil. It is true that stagnant water near the surface is fatal. It is probable that a very stiff and impenetrable hardpan within a foot or two of the surface might make success impossible, but the station records give no notes on the latter point. Because of its long tap root, alfalfa seems especially adapted to a deep soil with the water table distant from the surface. The root hairs on slender rootlets are to be found to a depth of several feet showing that the plant takes its food from layers of the soil below the reach of the cereals. This fact may partly account for the success on light sands.

PREPARATION.

It has been assumed that the crop with which we are dealing does not differ from spring grain in demanding a suitable seed bed, hence it has been the invariable custom to sow the seed on ground plowed to a good depth, but not deep enough to bring up a cold and unaired subsoil, well harrowed and rolled to break up lumps. To compact the surface soil to establish capillary connection with the subsoil is, of course, essential.

The influence of the previous crop on the growth of alfalfa has been observed, although the data is not sufficient to warrant definite statements. Where alfalfa has succeeded itself after four years of cropping, the new seeding has made a very slow growth, possibly by reason of

the exhaustion of the potash and phosphoric acid. Where alfalfa has followed vetches a peculiar segregation of the nodules was noted as has already been stated, page 137. So far other crops seem to have been neutral in their effects on the succeeding alfalfa.

Experiments have been undertaken to note the influence of various fertilizers. None of the college soils are acid yet lime is invariably applied before the seed is sown. On one series of plots a strip was sown to air-slaked lime and the next to the lime cake from a sugar factory. The crop is the same over the two plots showing absolutely no difference between them. The application of nitrate of soda did not seem to either hasten the growth or increase its magnitude. In another case the nitrate gave a visibly darker color to the alfalfa than did an excess of either phosphate or potash, but the growth of the young plants is no more rapid where the nitrate is applied than elsewhere. An examination of the roots showed a larger number of nodules on the plot to which phosphoric acid was applied and the nodules were larger.

METHODS OF SOWING.

In the earlier work the seed was sown in rows 18 inches apart and cultivated. The results were entirely satisfactory, although the plots were too small to make the record of yield valuable. Where it is desired to be sure of a catch, the method is to be recommended. Under usual field conditions the seed might better be sown broadcast because, if rain follows when the crop is cut, it is difficult to cure on the raw ground. The wheelbarrow seeder or some similar appliance may be used. A harrow follows, burying the seed to a depth of half an inch. If a nurse crop is used the seeder may be put in front of the grain drill when the hoes of the drill will cover the seed fully deep enough. Some correspondents recommend this method but it has not been tested at the station.

A nurse crop is not recommended. If the season should turn out to be one with the rain well distributed it is possible that the nurse crop will not only do no harm but will help the alfalfa. In 1903, an area sixteen rods north and south by fourteen rods east and west was sown to alfalfa in strips one rod wide, the strips running east and west. The question of a nurse crop was here studied. Plot 9 had 15 pounds of American grown seed per acre, sown April 18 after oats had been drilled at the rate of one bushel per acre. Plot 16 was treated in the same way except that 20 pounds of seed was used. Plot 9 had the oats removed as they began to head out, while plot 16 carried the oats to maturity. The season was a wet one and the oats lodged badly. All plots stood the winter well and were cut three times in 1904, on June 7, July 11, and August 30. The results of a comparison of the plots bearing a nurse crop with adjacent plots having none do not show an injury from the nurse crop. Plot 9 with a nurse crop gave a total yield of 641 pounds of dry hay, while plot 8 gave 574 pounds and plot 10, 664 pounds, neither having a nurse crop. Plot 16 with a nurse crop yielded 696 pounds of dry hay, plot 15 without, also 696 pounds. It must not be forgotten that the rainfall in 1903 was evenly distributed through the growing months and the nurse crops did not have the usual effect of reducing the amount of moisture in the soil below a sufficient supply for the alfalfa.

AMOUNT OF SEED.

A comparison of two quantities of seed was made on the station plots. On the 18th of April, 1903, two plots were sown at the rate of fifteen pounds per acre and two at the rate of twenty pounds. In the spring of 1904 the stand was equally good on all four plots. The yield of hay was practically the same where fifteen pounds were sown as where twenty were used. The season of 1903 had the rainfall distributed all through the season and there was no drouth. Where the seed has a high per cent of germination, where the ground is well prepared and well fertilized and where the rainfall is so distributed as to leave no drouth during the season, fifteen pounds of seed is evidently enough; but since no man can foresee what the season will be, it is wise to sow twenty pounds.

VARIETIES.

The varieties tested have been American grown, locality unknown, Colorado, Utah, Sand Lucern, and Turkestan furnished by the Department of Agriculture at Washington. The American grown seed was purchased in the open market. Its color was good and the seed was perfect in brightness and freedom from dodder and other weed seeds. The Colorado was also a good sample, clean, bright, and free from impurities. The Sand Lucern was not free from weed seed nor had it as good color or as bright appearance as the American. The Turkestan was somewhat peculiar in color but was a fair sample.

No great difference in appearance of the crops was noted in 1903. The seed was sown on April 18 and 21. On May 30 it was noted that there was a good stand, the American grown rather taking the lead. On June 8, June 29, July 20, and August 7, the plots were clipped, the guards of the mower set six inches high. Naturally the clippings were left on the ground.

On the fourteenth of September it was noted that the Sand Lucern was not as high as the Colorado or American grown. The Turkestan was notably small.

The observations in 1904 began April 21. The alfalfa was growing nicely on all plots with some poor spots on the plots with American grown seed. The Utah had a good stand without poor spots. The same was true of the Colorado. The Turkestan in one plot was poor, in the other fairly good. It was farther noted on the fourth of May that the Sand Lucern was making a rather more rapid growth than the other varieties.

On the eleventh of May, after a hard frost on the night of the tenth, the alfalfa drooped but soon straightened up and showed no permanent injury. There were hard frosts on the fifteenth and sixteenth of the month. The alfalfa leaves turned yellow on the edges and some of them shriveled up and dropped but the plants soon recovered. The crop was cut June 7, July 11, and August 30. The plots were one rod wide and fourteen rods long. There were sixteen plots in the experiment altogether, numbered consecutively from the north to the south. The whole area was lacking in homogeneity and it was necessary to separate the plots of each variety that the comparison might be fair. The following table records the height of the alfalfa on the date of the cutting and the weight of dry hay on each plot:

Plot.	Variety.	Seed per acre. lbs.	Sown, 1903, April.	June 7.		July 11.		August 30.		Total hay, lbs.	Yield per acre, lbs.
				Height, ins.	Hay, lbs.	Height, ins.	Hay, lbs.	Height, ins.	Hay, lbs.		
2.	Salauer (Utah).....	20	21	22.5	288	20.3	222	12.8	135	645	
10.	Salauer (Utah).....	20	18	22.5	287	19.1	244	13.2	133	664	7,480
3.	Colorado.....	20	21	23.0	200	18.7	214	11.3	121	535	
11.	Colorado.....	20	18	22.5	301	19.7	262	14.7	150	713	7,131
4.	Sand lucern.....	20	21	21.0	252	18.5	195	11.0	105	552	
12.	Sand lucern.....	20	18	22.5	266	19.3	228	13.9	120	614	6,663
5.	Turkestan.....	20	21	20.5	320	18.2	162	12.0	83	475	
13.	Turkestan.....	20	18	21.5	258	18.6	198	12.8	107	563	5,931
15.	American grown.....	20	18	24.0	298	19.6	235	16.1	163	696	
1.	American grown.....	20	21	22.5	280	19.2	171	13.2	135	586	7,326

These are the yields of a single season and do not represent conclusions as to the relative values of these varieties.

In the spring of 1905 the Sand Lucern and Turkestan plots are quite notably better than the others. Plot 15 was badly winter killed while plot 13, Turkestan, maintains an almost perfect stand. Plot 3, Colorado seed, is visibly poorer than 4, Sand Lucern, or 5, Turkestan. A glance at the heights of the plots on August 30 does not indicate that up to that date the Turkestan alfalfa was much shorter than the other varieties, but after the last cutting it seemed to recover more slowly and was much shorter throughout the rest of the season. In the late fall it was the least promising of any of the varieties tested, but in the spring of 1905 it gives evidence of greater hardiness than its competitors. It did not yield as much as the Sand lucern and much less than any of the American varieties. Which of the many kinds of alfalfa shall be finally selected for general use in the State is an open question.

LATE CLIPPING.

In 1904 the season was wet after the last cutting, August 30. There was, consequently, a tall and fairly thick after-growth. By the seventh of October this after-growth was fully knee high. The question then arose whether for the sake of the crop in 1905, this growth ought to be clipped. To test the matter the west half of all plots was clipped, using the mower with the guards set as high as possible. The clippings were left as a mulch. They were not thick enough to smother the plants.

At the date of this writing (May 10, 1905) it is very evident that the clipping was a serious injury to the field, since, although the ground is poorer where the clipping was not done, the alfalfa is taller, stronger and a better stand.

COMPOSITION OF THE THREE CUTTINGS.

Samples of the harvests of June 7, July 11 and August 30 were taken for analysis with the following results:

	Ash, per cent.	Total Protein, per cent.	True proteids, per cent.
June 7	10.39	14.39	8.60
July 11	10.00	14.57	8.78
August 30	8.91	16.57	2.02

The small per cent of true proteids in the third cutting is very significant as it is to the true proteids, not to the amids that the total protein owes its feeding value. The hay from the third cutting ought to have less feeding value than that from either of the earlier harvests of the year, notwithstanding its apparent greater richness in total protein.

HARVESTING.

The harvesting of the crop has not presented unusual difficulty. The first cutting, coming as it does early in June is rather difficult to cure because full of juice and the weather usually wet. Here is the place where hay caps are called for and are used at the station. They are not expensive and will last, with reasonable care, for many years. The alfalfa is cut after the dew is off on a bright day, stirred up with a tedder or a side delivery rake, left in loose windrow until the dew begins to fall in the late afternoon when it is piled up into rather large heaps and covered with hay cap. The hay is then allowed to sweat, is shaken out carefully to prevent loss of leaves, is allowed to dry as other hay and hauled to the barn with as little handling as possible and in a condition rather more moist than is usual with clover hay. The danger of hauling too green is that spontaneous combustion may result as is shown by investigations in Kansas. At this station no bad results have followed hauling alfalfa hay when in the tough stage, where it may be twisted into a rope. The danger of allowing the hay to become too dry is that the leaves are lost and the leaves are the part of the plant richest in protein.

EXPERIENCE OF MICHIGAN FARMERS.

The Experiment Station has distributed small quantities of alfalfa seed to a large number of farmers and has repeated the distribution for two or three consecutive years. Seed has also been obtained by enterprising farmers from other sources and experiments have been widely scattered over the State. In 1904 and 1905 the farmers have reported their success to the station. Extracts from some of these letters will be of interest and value. Of seventy-six reports, thirty-two record failures, twenty-four record partial success for a single year and sixteen, cases where the alfalfa had lived at least two years.

The failures are ascribed to many causes, chief among which were the severe winters of 1902-3 and 1903-4. In these cases the damage seems to have been done by coats of ice in the spring rather than by extreme cold weather. It is significant that alfalfa seems to do well in the upper peninsula where the thermometer falls lower than in the southern peninsula, but where there is a certainty of a good cover of snow from early fall to late spring, though even here it is seriously if not fatally injured by the winter.

In Special Bulletin No. 31, Superintendent Geismar of the Upper Peninsula substation says: "The yield of the alfalfa plots has increased each year and the large yield of the past season shows that the plants are

now fully established and that this valuable crop is well adapted to Upper Peninsula conditions." A later report from the substation, written in April, 1905, since the snow has left the ground, shows that the plants are nearly killed. There was a good coat of snow over the ground all winter and the injury to the plants is not easily accounted for unless the dense covering with a hard crust for part of the winter be the cause. The fact remains, however, that even under conditions as favorable as those surrounding the plots at Chatham, alfalfa is still in the list of crops to be experimented with rather than among the established certainties.

It does not seem to have been difficult to secure a stand, but either the drouth or the winter kills the crop when established.

A. H. Foster, Allegan, reported in December, 1904, that four acres of alfalfa sown at the rate of 20 lbs. per acre in the spring of 1903, was winter killed, the German seed standing the winter rather better than American grown, and that a field of common red clover sown in winter wheat beside the alfalfa lived through the winter almost perfectly.

F. L. Church, of Antrim County, reports the sowing of sand lucern furnished him by the college in 1903. He sowed part of the seed alone and part of it with Telephone peas. Where sown alone it was so weedy that he mowed it on the fifth of July. The patch did not grow much afterward. In mid-summer of 1904 the alfalfa sown with the peas was better than where sown alone. One-eighth of an acre sown in the peas in 1903 yielded at the first cutting of 1904, 286 lbs., or 2,288 lbs. of dry hay per acre.

C. C. McDermid, Calhoun County, reports that he sowed alfalfa May 1, 1901, at the rate of 16 lbs. per acre, which was lightly covered. One-half was Turkestan and one-half was sand lucerne. He could see no difference in the plants as they grew side by side. "Both have made a moderate growth each year since (April 19, 1905), have never seriously winter killed, and are looking well now, but are too thin on the ground for best results."

"They have never yielded a profitable crop of hay, the clover alongside beating them more than three to one. The crop last year was better than ever before, probably the result of gradual soil inoculation with the alfalfa bacteria from some unknown source. The plants, or some of them, now have small nodules on the roots like those on red clover in size and general appearance."

"My field is high and well drained, soil mixed sand and clay loam; good garden soil."

Alexander Watson, of Dowagiac, writes that he has an eight acre field of alfalfa standing through six years and looking sound in the spring of 1905. He says: "I have never used my field for anything but a pasture field, but it is great for that. In all these years it has never killed out in any way, neither winter nor summer. All the original planting is still there. My land is sandy with a hard pan within a few feet of the surface."

H. C. Hatch, of Dowagiac, writes: "I sowed my alfalfa August 22, 1899. It stands the winter all right. I cannot do without it now, although I have always pastured it. I shall sow ten acres more this fall (1905)."

Earl W. Durfee, of Litchfield, writes: "In May, 1902, I sowed sixteen acres to alfalfa. It started as nice as a person could ask. No weeds grew on the piece to choke it out, but it kept getting thinner and thinner.

I was so in hopes that it would come on that I left it. I clipped it every year, but never cut any of it for hay till last year, when I mowed about half of the piece and the other half I have plowed up this spring. In some parts of the piece that I have left the alfalfa is nice, in other parts it amounts to almost nothing."

"In 1903 I sowed twenty acres to alfalfa. This came up very nice also. The following winter was very severe and the most of it winter killed. I plowed it up a year ago this spring. Alfalfa has been quite extensively sown in this vicinity, but it did not do well and the most of it has been plowed up. I know of only one piece, a neighbor has three acres, which was sown three years ago."

Dennis Miller, Eaton Rapids, writes: "My experience with alfalfa has not been very successful. I sowed two acres, using 25 lbs. of seed to the acre, about May 25, 1903. The ground had been plowed early in spring and worked frequently before sowing the seed. It was a good stand in 1904, with the exception of a touch of the yellows along in August. In the spring of 1905 I find that it is all winter killed, with the exception of about a half acre lying next the woods. The soil is sandy with a little clay."

W. B. Williams, of Charlotte, writes, under date of April 9, 1904: "Some fifteen years ago a friend gave me a few quarts of alfalfa seed with directions for sowing. I must not sow oats or any other crop with it. I had a small piece, about a third of an acre, sandy loam. I manured it thoroughly, and sowed the seed. The alfalfa did not make much show the first year. The second year there were fewer weeds and more alfalfa. The third year I mowed it three times, and this I continued to do for many years. I think it was in its prime the fourth year. The first crop of the season was always the heaviest, the second, six weeks later, a little lighter, and the third was quite light, though it paid for cutting. I think I kept it some eight or ten years. Frequently in the spring the roots were so few and scattering it seemed to have failed, but in a few weeks it would come on quite thick. It did not show much sign of dying out until I allowed a man to stake his cow on it for pasture. When I plowed it up I found roots five and six feet long, although it was not hard to exterminate. I am inclined to think it would do well on the sandy pine lands. I have my doubts whether it will stand pasturing."

In Huron County two correspondents tried alfalfa for two consecutive years, but in both cases it was killed by a hard winter.

Three correspondents in Jackson County report attempts to grow alfalfa, but winter killing has prevented success. In one case the alfalfa survived for several years, but is now extinct.

J. B. Duncan & Son, of Vicksburg, write under date of April 13, 1905: "On a few spots in our piece of alfalfa it appears to have been partly killed out during the winter. The amount of loss will probably be about 20 per cent. The parts not killed are now looking well and we hope will make a fair crop. The nodules are just beginning to appear on the roots. The seed was inoculated by cultures obtained from the Department of Agriculture at Washington and was sown last year."

In Lapeer County it was tried on muck, sandy loam and clay loam, but in each case it was a failure. Another man had had reasonably good success with it for several years.

In Lenawee County, alfalfa wintered well on some pieces while on others it was killed in the winter of either 1903-4 or 1904-5. A. J.

Allen, from Clinton, writes, May 20, 1904: "Alfalfa is pretty well killed, as are clover and wheat, except near the fences and in low places where there was a covering of snow. In 1899 I had some alfalfa frozen to death also. Last year I had twenty-two acres, all on clay. It was cut three times and yielded from two to five tons per acre. I believe it would do well on any soil if the water is not too near the surface of the ground."

"I have had good success in seeding on corn stubble, if enough dirt can be scratched up to cover the seed. That is all that is necessary. It has caught and done as well this way as where the ground has been plowed in the fall and subsoiled. I believe it is the best feeding crop that can be raised on the farm if the killing winters do not come too often. I used a side delivery rake and hay loader. Last year I put in some alfalfa under circumstances where red clover would have spoiled. The alfalfa came out in good condition. I filled a silo six feet in diameter from the last cutting for chickens. It kept well. There was no waste. It seemed to dry out a little, but did not spoil."

A farmer near Tipton notes that June grass is the worst enemy of alfalfa in that section, with the possible exception of the hard winters.

Concerning the experience of farmers about Tecumseh with alfalfa, Mr. J. R. Keeney, of Tecumseh, gives important testimony, writing in May, 1905. He has two acres of alfalfa, cut three times in 1904 and twelve inches high in places on the 7th of May, 1905. He reports that Mr. Howard, of Tecumseh, has a small field looking fine. Mr. William H. Osborne, of Tecumseh, has cut a certain field for several successive years. This field has plenty of nodules. It is along the road where there is plenty of sweet clover, to which plant the inoculation may be due. Mr. Abner Wilson, of Tecumseh, has five acres sown in 1904 with inoculated seed. No nodules yet discovered. R. D. Harrison, of Tipton, has ten acres which looks fine. William Fisher has five acres near Tecumseh, now in excellent condition. John T. Clark, of Clinton, has grown ten to thirty acres for years with success. His Turkestan alfalfa has plenty of nodules. Charles Clark of Clinton has a large field which is in excellent condition, sown last season and yielding a crop of hay the season when sown.

Mr. Keeney states that there are many other fields about Clinton which have withstood the winter successfully and are in good condition now. There is so much sweet clover in the vicinity, especially along the highway, that he is inclined to think the soil is well inoculated. He has known of no failures where the alfalfa has had a chance.

This testimony, combined with what precedes and follows, seems to indicate that alfalfa is a very promising crop for Lenawee County.

C. A. Jewell, of Hudson, reports his experience briefly, as follows: Two experimental fields were sown in the spring of 1903. One was a strip across a corn field, rolling and uneven, the soil varying from light sand to heavy clay. The seed was sown without a nurse crop early in the spring. A heavy rainstorm came on, on the day of sowing, preventing harrowing and making the stand very uneven. The second field was an old pasture cut off from the farm by a railroad. It had not had manure for years. It was plowed early and frequently harrowed until after corn planting, when the ground was in perfect tilth. Twenty pounds of seed was sown per acre after two barrels of air slaked lime per acre had been applied. The seed came up quickly, thickly and evenly, and made a very rapid growth. "Following the orthodox teach-

ing, I clipped it with a mowing machine, I think three times, whenever the heads began to blossom, running the mowing machine four inches high, cutting off the plants mostly below the leaves and checking the root growth every time. A few handfuls of alfalfa seed being left, it was mixed with red clover and timothy and sown on the small, irregular shaped patch outside of this acre. It was not handy to mow and was left to take care of itself throughout the season. The winter following, 1903-4, was the severest in some ways ever known in this section. A thick sheet of ice lay upon the earth through December, entirely destroying the red clover and injuring the alfalfa very badly, killing it all in the hollows and at least half the plants in other parts, except the little patch not clipped, which was entirely uninjured, every plant seemingly alive, though all the clover amongst it was killed. I shall never clip alfalfa the first season again."

Alfalfa has been tried in Manistee county and in other sections of the State in that latitude. It has not done very well notwithstanding the fact that the ground is usually covered with a good coat of snow. Reports from Mecosta county indicate that the same statement is true for that region.

From Newaygo county the reports are quite discouraging. One farmer near Fremont reports success for a single year while others agree in condemning alfalfa when grown under present methods.

In the upper peninsula, besides the reports from the State Station at Chatham, there are letters from Menominee county showing that the crop is doing well there. Ira Carley of Ingalls reports that he has one and a half acres of alfalfa which was sown with oats in 1903. Three crops were cut in 1904 on June 19, July 24 and August 28, the last crop being the best. The hay is fed to all kinds of animals including hogs, which do well on it. He also sowed a field in 1904 which survived the winter in good shape and both fields are promising in the spring of 1905.

From the letters and official reports from the upper peninsula it is safe to draw the conclusion that alfalfa is a safe crop to experiment with north of the straits and that there is reasonable assurance that it will become a leading forage crop for as much of the upper peninsula as has good soil and a certainty of a continuous cover of snow during the winter.

In Oakland county alfalfa has been tried a great many years. Mr. C. W. Bennett of Milford sowed one-half acre of alfalfa twelve years ago on rich, well drained clay loam. It has been cut two and sometimes three times each year since, furnishing good yields of hay. The June grass is crowding out the crop to such an extent that the field will be plowed this year. Mr. Harper Gardner of Oxford has a small field which has been mowed three times a year for six years. The alfalfa hay has proven invaluable. Fred M. Daines of Farmington reports success with alfalfa both for hay and pasture. He recommends the crop for situations where the field is to be permanently seeded.

Perhaps the man who has had the longest and most successful experience in Oakland county is A. D. De Garmo of Highland. He writes under date of March 29, 1904: "I have sown a little alfalfa seed nearly every year for twenty years to see what it was like and to learn if it would withstand our winters, and conclude that it is as hardy as our June clover. Neither will stand severe cold after

being pastured short, on our light soil. At one time I had thirty acres of alfalfa and the same amount of red clover. I pastured this field one season; then came the hard cold winter of six or eight years ago and killed the whole area, both clover and alfalfa.

Some six years ago I sowed one and one-quarter acres of alfalfa on the first of June at the rate of twenty pounds of seed per acre. The field is a sandy loam near the barn and was in good tilth. The seed germinated readily and grew nicely for a time until the drouth came. We had no rain all summer hence the alfalfa only attained a height of four to ten inches. Few weeds grew and these were pulled out by hand. The alfalfa was not cut the first season.

The following spring that alfalfa grew first and faster than any other crop on the farm, rye not excepted. On June 1st we cut three good loads of nice hay. Forty days later we cut two large loads of hay. The plot was cut again about the last of August but was not raked. The following year the alfalfa patch produced about the same sort of crop. The third year it was pastured. The low temperature of the following winter with the ground bare killed half of the plants."

In Wayne county a correspondent writes from Belleville under date of April 3, 1905, that he sowed ten acres to alfalfa in 1903, rolling and top dressing with fine manure. He secured a fine catch; ran the mower over it twice in 1903. The next winter killed nearly all of it.

Mr. George C. Peterhans of Plymouth reports that in 1903 he seeded a plot of ground at the rate of sixteen pounds per acre, but regrets that he did not apply twenty pounds. On the tenth of April, 1905, the crop was in fine condition. He had a good crop of hay in 1903, cutting it in September.

Mr. Fred Rocker, also near Belleville, cut thirty tons of alfalfa hay from ten acres of sandy soil in one season and then pastured seventeen head of cattle on the meadow all the fall after cutting this hay. As a result he found the alfalfa in bad condition in the spring of 1904. N. A. Clapp of Northville reports on April 1, 1905, that the field of alfalfa of which he was proud in 1904 was entirely destroyed by the winter.

William H. Bailey of Hart, in Oceana county, reports good success with alfalfa after five years' experience. He finds the worst enemy to be the June grass.

Mr. P. B. Reynolds of Shiawassee county reports that he sowed an acre at the rate of twenty pounds of seed and secured a good stand, but the crop was entirely destroyed by the winter.

It is impossible to print all the letters received concerning this crop, but enough has been given to show the present condition of alfalfa in the State and the attitude of the farmers toward it. Perhaps the most significant fact brought out by the correspondence has been that winters are a serious menace. Alfalfa is peculiarly a crop to be left in somewhat permanent possession of a field. It requires two seasons at least to secure the needed root development. It is undoubtedly true that thereafter it will draw a large per cent of its plant food from strata below the reach of the roots of the cereals. It is illy adapted to a short rotation. It is an expensive crop to start. For all these reasons the winter-killing is a serious matter. It is to be hoped that strains of the most promising varieties will be developed which will become as thoroughly acclimated as clover and timothy and better able to endure Michigan winters.

MICHIGAN
STATE AGRICULTURAL COLLEGE
EXPERIMENT STATION

THE WORK AT THE SUB-STATIONS.

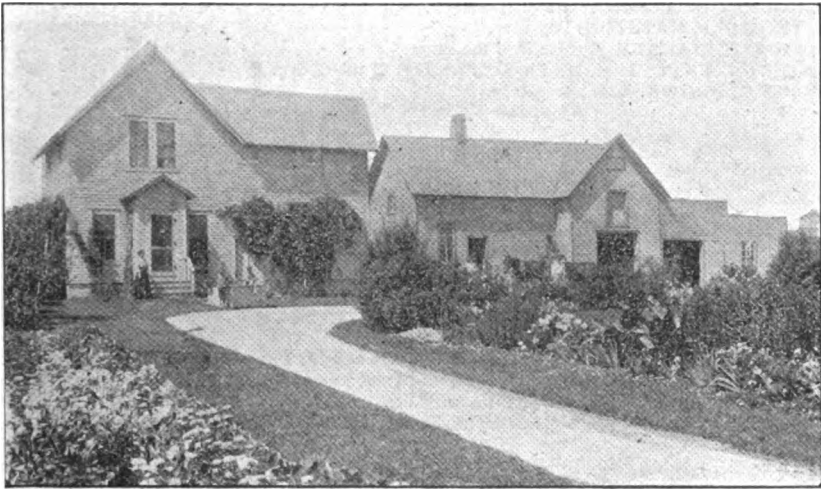


FIG. 1.—Residence, Office and Stable. South Haven Sub-Station. •

REVIEW OF SPECIAL BULLETINS 27, 28, 30, AND 31,

BY

L. R. TAFT AND C. D. SMITH.

AGRICULTURAL COLLEGE, MICH.
1905.



The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

The Station

MICHIGAN AGRICULTURAL EXPERIMENT STATION

Postoffice and Telegraph Address, - - - Agricultural College, Mich.
 Railroad and Express Address, - - - Lansing, Mich.

A DEPARTMENT OF THE STATE AGRICULTURAL COLLEGE, AND, WITH IT, CONTROLLED BY THE

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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.

THE WORK AT THE SUB-STATIONS.

Review of Special Bulletins 27 and 30, Reports of South Haven Sub-station for 1903 and 1904, by L. R. Taft.

Review of Special Bulletins 28 and 31, Reports of the Upper Peninsula Sub-station for 1903 and 1904, by C. D. Smith.

SPECIAL BULLETINS 27 AND 30.

Reports of South Haven Sub-station for 1903 and 1904.

BY L. R. TAFT.

The report of the South Haven Sub-station for 1903 was issued in April, 1904, as Special Bulletin No. 27. It is devoted largely to notes upon new varieties of orchard and bush fruits which have given one or more crops. It includes red and black raspberries, blackberries, currants, grapes, gooseberries, cherries, plums, peaches, pears, apples, quinces and nuts. Lists of the standard sorts that have been thoroughly tested and found desirable are also given. Special attention is also paid to the conditions, climatic and otherwise, under which the various fruits were grown.

The report of the sub-station for 1904 was printed in April, 1905, as Special Bulletin No. 30. This is a continuation of the work included in the report for 1903.

The following are among the varieties that received favorable mention: Strawberries, Aroma, Brandywine, Clyde, Dunlap, Ernie, Excelsior, Lincoln, Glen Mary, Sample and Seaford. Raspberries, blackcaps, Eureka, Cumberland, Kansas; red varieties, Cuthbert, Early King, Marlboro, Miller and Phoenix. Gooseberries, Downing, Josselyn and Pearl, of the American, and Columbus, Keepsake and Chautauqua of the European kinds. Currants, Red Dutch, Wilder, London, Cherry and Fay as red varieties; White Dutch and Black Naples are also desirable kinds. Grapes, Moores, Campbell, Ohio, Worden and Concord, black; Diamond, Niagara and Pocklington, white; Delaware, Vergennes and Brighton as red sorts. Cherries, Dyehouse, Richmond, Montmorency and Montreuil of the sour varieties; and Napoleon, Windsor, Plymouth and Governor Wood of the sweet sorts. Peaches, Triumph, Brunson, Oceana, Longhurst and Gold Drop were among the more hardy kinds; of the promising new sorts, Dewey, Banner, Carman, Emma, Hieley, Welch and Worth are highly spoken of; Michigan, St. John, Champion, Engle, Elberta, Kalamazoo, New Prolific, McCollister and Salway are among the best of the standard sorts. Plums, Red June, Abundance,

Burbank and Satsuma of the Japan varieties; Bradshaw, Lombard, Fellenberg, Arch Duke, Black Diamond, Grand Duke, Bavay and Monarch of the European sorts are well-known and profitable kinds for home use or market; Shropshire and French Damson plums are generally very productive and bring the highest price. Pears, Clapp, Bartlett, Flemish, Howell, Angouleme (Duchess), Seckel, Clairgeau, Dana Hovey, Kieffer, Lawrence and Winter Nelis are among the surest and best sorts. Notes are also given upon nearly eighty varieties of apples. Among the new or little known sorts, especial mention is made of Boiken, Newby, Sutton Beauty, Fanny, McIntosh, Ontario and Hubbardston. In the bulletins referred to, full descriptions are given of the above named sorts as well as several hundred others, many of which are of much merit.

In addition to the notes upon the varieties under trial, especial attention is given to the results obtained in a series of spraying experiments in which careful tests upon a variety of fruits were made of several dust sprays, soda-bordeaux and a variety of mixtures for the control of the San Jose scale in addition to the ordinary insecticides and fungicides. In brief, none of the dust sprays give as good results as the liquid sprays except perhaps against the plum curculio. They had little effect in controlling the curl-leaf of the peach or the scab of the apple and in the case of varieties that are subject to the attack of these diseases, the injury where the dust mixtures were used were so great as to practically cause the loss of the crop.

Soda-bordeaux, although not nearly as valuable as the ordinary lime mixture, answers a good purpose in controlling fungous diseases late in the season when the lime mixture would be likely to discolor the fruit.

Of the remedies for the San Jose scale, nothing was more effective than the ordinary sulphur, lime and salt mixture, using 25 pounds of lime, 15 pounds of sulphur and 8 pounds of salt for 50 gallons of water. Practically as good results, however, were secured when no salt was used, and in preparing small quantities, when the heat from the slaking lime was utilized for boiling the mixture. As the scale has not obtained a lodgment in the station orchards, the various mixtures were tested in three orchards in other parts of the county on peach and apple trees. Excellent results were obtained in the case of the peach trees in all places, as, at the end of the season, the infested trees were practically free of the scale indicating that when the work is thoroughly done this destructive insect can be controlled upon peach trees by spraying them once in two years. As the sulphur and lime mixture is also a remedy for leaf-curl and to some extent for the rot, annual applications can generally be made with profit in orchards where the scale has appeared.

A test was also made of the use of caustic soda as a remedy for the scale. When used at the rate of six pounds in 50 gallons of water it proved of little value, as a sufficient number of the scale survived to encrust the trees at the end of the season even worse than they were at the beginning. One serious objection to the use of this solution is its caustic effect upon the face and hands of the operators, and especially if it reaches the eyes. It has, however, been used at even greater strength than the above, the amount in several cases ranging from

12 to 25 pounds of caustic soda in 50 gallons of water. These strong solutions not only destroyed the scale, but freed the trees of their rough bark and gave them a fresh, glossy appearance.

The results obtained when spraying apple trees for San Jose scale were less satisfactory than with the peach, and most other fruits, as the trees are generally not only larger and with thicker heads than other fruit trees, thus making them more difficult to spray, but the loose and rough bark upon the trunks and larger branches make it almost impossible to reach all of the scale, and the same is true regarding the fuzzy covering upon young twigs of many varieties. For these reasons the results ordinarily secured when spraying apple trees have not been as good as with the peach, especially from the first one or two applications.

The results from various experiments with cover crops, both at the South Haven Station and cooperative, are given in both of the bulletins. Of the leguminous crops which are of especial value for supplying nitrogen, winter vetch, mammoth clover and crimson clover have been valuable in the order named. Cow peas and soy beans are of no value unless they can be sown as early as the first of July under favorable conditions. Considered only as cover crops, barley has been most satisfactory, having larger leaves and stouter stalks than oats. Field peas have been used with both of these crops with good success.

As fifteen years have elapsed since the location of the sub-station at South Haven, the following brief notes regarding the station and its work may be of interest. Previous to that time experimental work in horticulture had been carried on at the Agricultural College, but as the location and climate is less favorable for fruit growing than in many sections along the shore of Lake Michigan, and in other important fruit regions in Michigan, it was felt that this interest merited more attention than could be given the College orchards and the State Board of Agriculture authorized the location of a sub-station in the "Peach Belt" at some point where the work of the station could be observed by fruit growers and where they could also obtain results that would be more reliable than those secured in the College orchards.

For a number of years the Hon. T. T. Lyon, at that time President of the State Horticultural Society, had under trial upon his premises at South Haven, a large collection of tree and bush fruits that were just coming into bearing. Mr. Lyon owned ten acres of land within the limits of the city of South Haven and within a few hundred feet of the shore of Lake Michigan. In the spring of 1889, arrangements were made with him for a report upon the varieties under test upon his grounds, but as it was thought best to place it upon a more permanent basis, a lease was obtained the following spring of the land belonging to Mr. Lyon and through his efforts and those of the Hon. C. J. Monroe, the five-acre tract adjoining the Lyon land on the south was purchased by some of the public spirited fruit growers of the section and presented to the State Board of Agriculture to be used as an experiment station. The following year Mr. Lyon erected a dwelling for his own use upon his land and also put up a convenient stable, packing-house and office building. The land was thoroughly under-drained and surrounded by a wire fence and a hedge of Japan quince. The soil is a light sandy loam underlaid at the depth of one or two feet with stiff clay.

Aside from a small area about the buildings which was planted with shrubbery, the entire tract was devoted to fruit. Nearly two hundred varieties of peaches and grapes and from one hundred to one hundred and fifty kinds of apples, pears, plums and cherries have been planted besides quinces, apricots, nectarines and nut trees of various kinds. Plantings were also made of the standard and new varieties of currants, gooseberries, raspberries, blackberries and strawberries.

In addition to careful notes upon the different varieties of fruits as they matured, a large amount of experimental work has been done in other lines, among which may be mentioned, first, spraying experi-

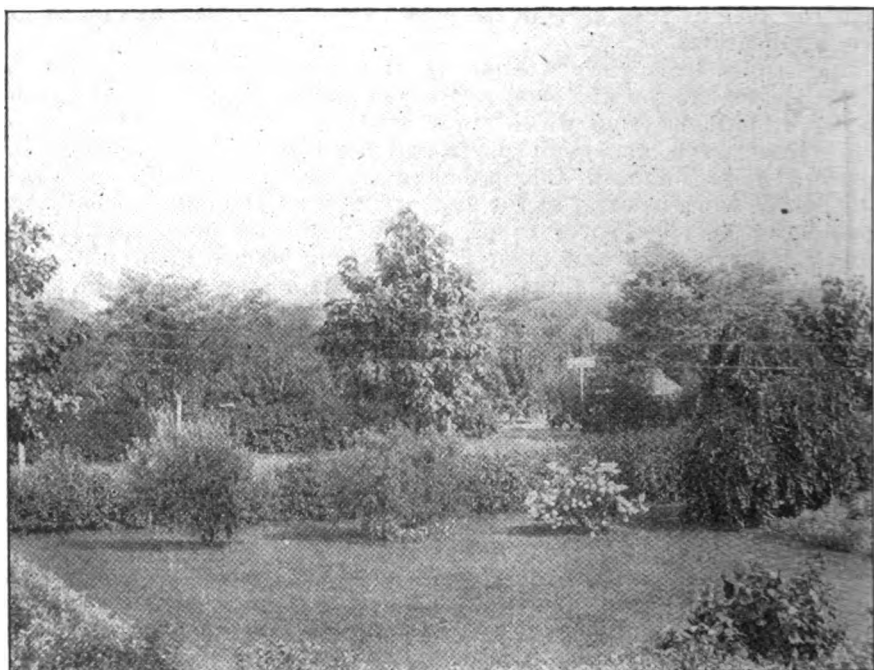


FIG. 2.—Lawn and Shrubbery. South Haven Sub-Station.

ments which embraced the testing of various insecticides and fungicides, including the strength that should be used, the number of applications and the date they should be applied. Various spraying apparatus has been secured and tested and reports have been issued from time to time.

Second, tests of different fertilizing materials for orchards and small fruit plantations. While the requirements for different soils vary, it is evident from experiments carried on at the sub-station and from cooperative work done at various points in that section that there are few bearing orchards upon which potash and phosphoric acid cannot be used to advantage. These elements can be secured respectively in muriate of potash, and acid phosphate or ground bone, although where it can be obtained at not to exceed six dollars per ton unleached hardwood ashes would be found more economical. Especially upon light soils and where the trees have produced several crops of fruit, nitrogen

has also been found lacking. While it can be obtained from stable manure and leguminous cover crops, these sources are not always available and recourse may then be had to nitrate of soda.

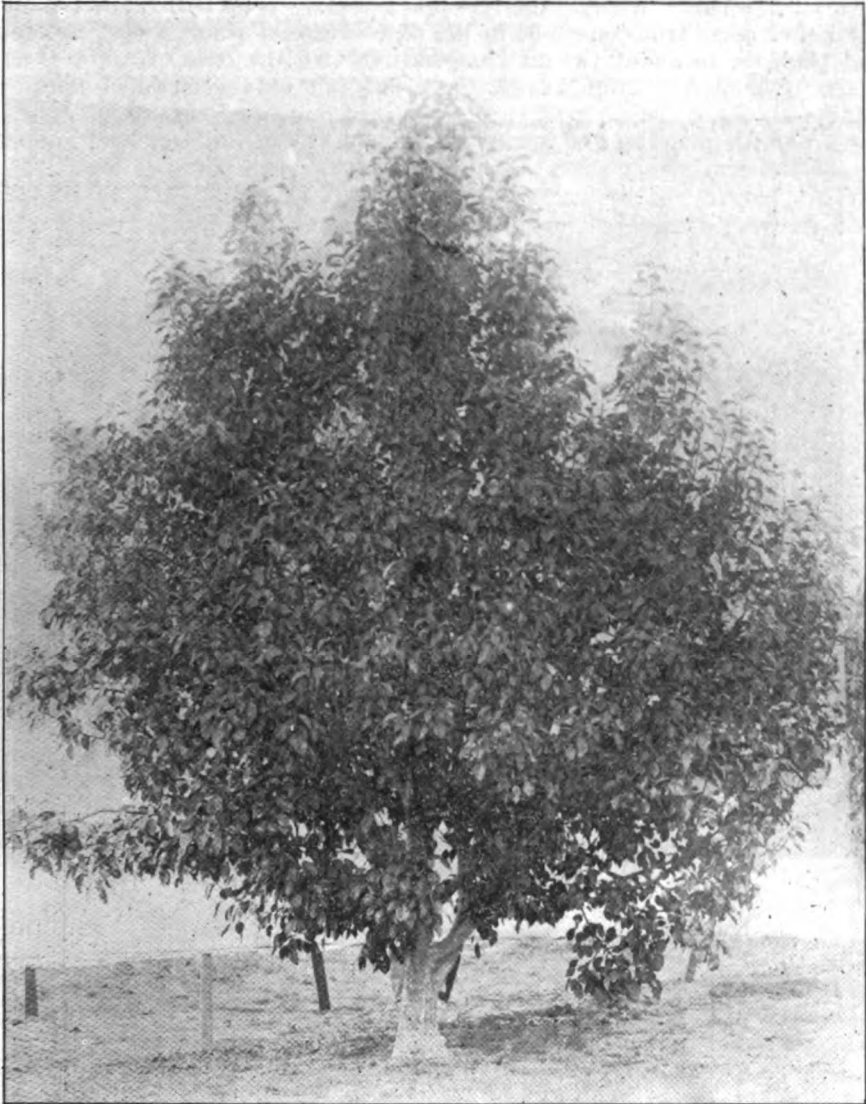


FIG. 3.—Pear Tree With Low Head.

Third, considerable attention has also been paid to cultivation and cover crops for orchards. As the soil is of a sandy nature and mulching material difficult to obtain, the orchards have been kept in thorough cultivation up to the middle of July or the first of August, and a very satisfactory growth has been secured. As continued cultivation soon results in the removal of the humus from the soil, it has been customary

for the past ten years to make use of some form of winter cover crop. The results with these have been briefly summarized above.

Fourth, pruning and training. Various methods of pruning and training the different kinds of fruit have been tested. The best results have been secured where the trees have been grown with rather short trunks, ranging from one foot in the case of dwarf pears, sweet cherries and peaches, to about two and one-half feet in the case of apple trees. When trained with high heads, there has not only been much greater injury from the cracking of the trunks, especially of cherry and peach trees, but the pruning and spraying, as well as the thinning and gathering of the fruit, have been found to be much more difficult than when



FIG. 4.—View in the Peach Orchard. Showing Effect of Heading Back.

grown with short trunks. For several years the new growth, especially of peach trees and of others that naturally formed open heads, was cut back about one-half. After that the heading in was confined to preserving the symmetry of the trees, except in the case of peaches where the leading shoots were cut back, occasionally even below the growth of the previous year. In order to lessen the injury from rot and other fungus diseases, as well as to heighten the color of the fruit, the trees were grown with fairly open heads.

In pruning the bush fruits, the new growth of blackberries and black raspberries was cut back to the height of two to three feet according to the varieties, but the red varieties were not headed back except perhaps in the case of a few kinds that branch naturally. No other pruning during the summer is given except to remove the old canes, but the following spring just before growth starts, all surplus shoots are removed and the branches are cut back to a length of about one foot.

The pruning of currants and gooseberries is done in the spring. It consists in the heading back of the new growth and the removal of the older plants as well as the weaker new ones, the idea being to leave four or five old and one or two new canes. Various trellises have also been used for training the grapes. A vertical trellis with two No. 10 wires at a height of three and four and one-half feet, respectively, from



FIG. 5.—Grapes on Horizontal Arm Trellis.

the ground has been most satisfactory, although a trellis with horizontal arms bearing three wires has given good results.

As indicated above, Mr. T. T. Lyon took charge of the sub-station in the spring of 1890 and continued to act as superintendent until 1899 when failing health made it necessary for him to give up the work. He continued, however, to occupy his residence until the time of his death which occurred in March, 1900. During the ten years in which Mr. Lyon was in charge of the sub-station he issued annual reports giving

the notes taken upon the different varieties as they came into bearing and the results secured from the cultural operations.

Upon the retirement of Mr. Lyon the charge of the sub-station was given to Mr. S. H. Fulton who had made a specialty of horticulture

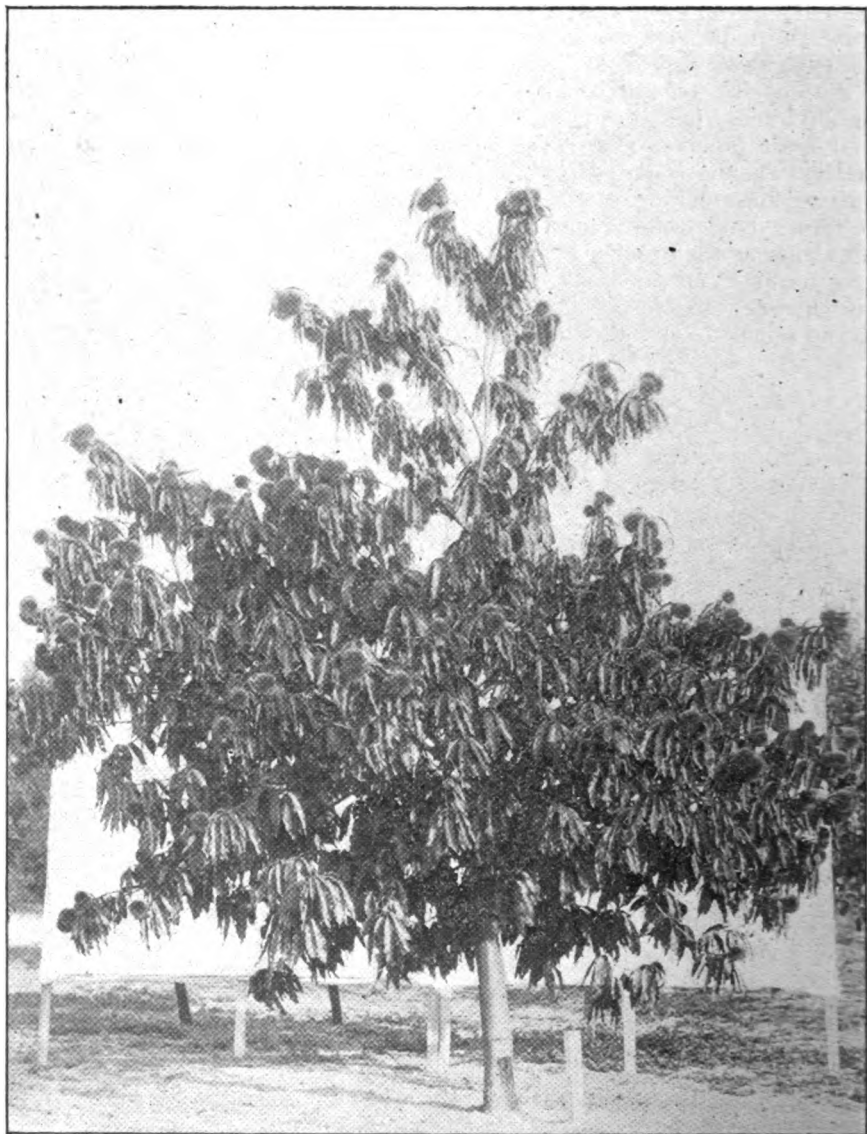


FIG. 6.—Paragon Chestnut in Fruit.

while a student at the Michigan Agricultural College and, after graduating, spent two seasons in some of the largest nurseries and orchards in the state of New York. In November, 1901, Mr. Fulton resigned to become horticulturist of the Georgia Experiment Station. He was suc-

ceeded by Mr. T. A. Farrand who had spent one year as a foreman with Mr. Fulton and thus had become somewhat familiar with the methods employed.

In addition to the work carried on at the sub-station and in the several cooperative experiments conducted in that section, the superintendents have, when their other duties permitted, responded to invitations to inspect orchards in the vicinity, where dangerous insects or diseases have appeared and advise regarding the remedies that should be employed. The advice thus given, as well as suggestions for handling the orchards, has been found very valuable, especially as several hundred fruit farms in Van Buren county have been purchased by Chicago parties who have had little or no experience in fruit growing.

From the opening of the sub-station exhibits of the different varieties of fruits have been made each year at the State and West Michigan fairs and, as the number of varieties in bearing has increased, the exhibits have become correspondingly larger until the number of varieties shown has in recent years reached about four hundred that were in condition at the time of holding the fairs.

SPECIAL BULLETINS NOS. 28 AND 31.

Reports of the Upper Peninsula Sub-station for 1903 and 1904.

C. D. SMITH.

The Upper Peninsula Sub-station was created by an act of the legislature approved in the early spring of 1899. By the terms of that act \$5,000 was appropriated for the purchase of a suitable tract of land in the Upper Peninsula and for the maintenance of the sub-station for two years. Late in July of that year the State Board of Agriculture, to which board the control of the sub-station was delegated by the law, located the site at Chatham, in Alger county, and accepted a donation of 160 acres of land immediately north and west of the railroad station, viz.: the S. E. one-quarter of Section 28, Range 46 North, 21 West. Chatham is eight miles due south of Au Train Bay on the south shore of Lake Superior and from 250 to 300 feet above its level.

When accepted, the farm was covered with a heavy growth of hardwood timber, principally maple, and was in the center of a large tract of hardwood covering several townships with few clearings, none larger than a dozen acres.

The donors of the farm agreed to clear, brush and stump forty acres and to remove the timber from the next forty but they partially failed to fulfil their agreement, contenting themselves with clearing something like seventeen acres. The State Board has, as a consequence, been obliged to go to the expense of clearing the land needed for the station plots. By the autumn of 1904 when Special Bulletin No. 31 was written, nearly forty acres have been cleared, with all stumps and stones removed.

The valley of the Slap Nick Creek, running, with high banks, from east to west, cuts the farm in two. The flood plain of the creek over-

flowing each spring and remaining too wet to work, takes up fully five acres of the cleared area. On both sides of the flood plain are alternately banks too steep to work and fairly level terraces upon which the plots are laid out. The clearing began on the entire east line of the farm and has extended westward forty rods.

Over most of the cleared portion the soil is thin, seldom exceeding three feet in depth. The northern third of the cleared portion has a deeper soil, in places fully fifteen feet deep. The underlying rock is a very calciferous sand stone. The soil is a dark colored sandy loam with abundant humus.

A house and barn have been erected on a terrace north of the creek. The fields have been fenced with wire fencing at no inconsiderable expense as many of the post holes had to be blasted in the rock.

The funds expended in the years ending on the dates mentioned are as follows:

June 30, 1901	.....	\$4,257 64
" 30, 1902	.....	2,501 55
" 30, 1903	.....	3,269 93
" 30, 1904	.....	4,402 87

CLIMATE.

The climate of the Upper Peninsula is distinguished from that of the Lower Peninsula by the greater depth of snow in winter and by the fact that the covering of snow is both certain and continuous. The ground seldom freezes at this sub-station. Potatoes may safely be planted in the fall with the certainty that they will not be frozen during the winter. The summer rainfall is compared with that at the Michigan Agricultural College in the following table:

	1900		1901		1902		1903		1904	
	College	Chatham	College	Chatham	College	Chatham	College	Chatham	College	Chatham
May.....	4.17	.....	2.36	3.72	4.71	2.11	2.63	4.12	2.40	6.34
June.....	2.57	.....	3.57	4.10	7.28	3.32	6.28	1.71	2.49	3.31
July.....	4.15	3.23	5.08	5.32	7.13	3.53	3.79	6.64	1.97	2.28
August.....	2.98	3.12	2.49	1.67	7.78	3.42	6.73	5.93	3.26	3.05
September.....	.87	8.83	1.67	5.23	5.88	2.21	2.86	3.34	2.35	4.32
October.....	2.77	.....	4.61	5.24	1.53	3.70	2.01	3.34	1.90	1.29
			19.78	25.28	27.31	18.29	24.30	25.08	14.37	20.61

CEREALS.

Wheat. The plots devoted to variety tests of the various cereals are too small to make the results more than suggestive.

Fall wheat has been grown with good success on clay soils in practically all parts of the Upper Peninsula, in the earlier work at the sub-station, Dawson's Golden Chaff rather leading the other varieties in hardiness and abundance of yield. The late frost blackens but does not kill the wheat. In 1903 plant lice seriously injured the crop and short-

ened the yield. In 1904 the close covering of snow seemed to smother the plants in winter, killing some varieties entirely. The Dawson lived through but the stand was poor. The indications from the small plots are that fall wheat is a crop to be recommended to Upper Peninsula farmers although wet harvests and plant lice are certain and hostile factors.

Spring wheat. Owing to the short seasons and cold weather during the summer, spring wheat does but fairly, the yield being from 12 to 20 bushels per acre. The velvet chaff seems to be the type of spring wheat of most value.

Oats. Early ripening varieties such as the Early Champion and University No. 6 should be selected as rust is bad on later sorts. The abundant rainfall causes a splendid growth of both straw and grain but it favors the growth of rust as well. No variety is rust proof no matter what its name may be and the only safeguard against the ravages of the disease is earliness of ripening.

Barley. Beardless sorts do well in the Upper Peninsula generally, and gave a good account of themselves at the station, the Champion being the best variety. Manchuri is another sort with a good record. Barley will be grown chiefly for feed in the Upper Peninsula to take the place of corn. The color of the grain is not, therefore, as important a matter as it would be farther south where barley is grown for malting. Barley thrives as far north as northern Norway in Europe and seems to be pre-eminently the cereal for northern latitudes.

Speltz or *Emmer* appears in every way like wheat except that the grain retains about it, at threshing, the glume which surrounded it. While growing it resembles wheat so closely as not to be distinguished from it. It is used for stock food, either threshed or in the straw and demands farther trial on a larger scale.

Corn. Extended experiments have been made with corn for several years. In no case has it ripened. The whole effort of the station is directed toward the selection of early varieties and strains of varieties which will ripen under the adverse conditions existing in a section of country where frost comes very late in the spring and very early in the fall. It is possible that the clearing of larger areas and the cultivation of more fields may so modify the climate as to permit corn to ripen with some degree of certainty. At present barley must be depended on for the supply of grain to take the place occupied by shelled corn in latitudes farther south. Corn itself will be grown for fodder and for silage.

FORAGE CROPS.

The grasses. Timothy is undoubtedly the leading grass in the Upper Peninsula as it is in the rest of the State, largely because it is hardy and because the period in which it can be cut for hay is long. While orchard grass must be cut as soon as it comes in blossom or the hay will be woody and unpalatable, timothy may be cut at any time after the heads are fully formed and before the seed hardens with the certainty that it will make fairly good hay. Again, timothy, while not making the best hay, is fairly certain in its yield, a statement which cannot be made of other grasses. Orchard grass has done well upon the station plots and is to be commended to the attention of Upper Peninsula farmers. Meadow fescue demands a moist climate. It is a

leading grass in England. Conditions at the Upper Peninsula station seem to favor it as a hay grass. Meadow fox-tail is worthy of further trial as a pasture grass because of its earliness. *Bromus inermis* which does so well in the west, seems to find in the Upper Peninsula a place that suits it. Kentucky blue grass, the universal pasture grass, also commends itself to the Upper Peninsula farmer. The trials of these grasses at the experiment station warrant these statements.

The *millet*s have made tremendous growths whenever sown since the establishment of the station. They will mature in a short season and although they are easily killed by the frosts they grow so rapidly that a good harvest may be expected when they are sown in May, or even as late as the first of June. When sown the fourth of June the Hungarian millet was harvested the third of September, yielding nearly four tons to the acre. Sown again June 8, 1904, it was harvested September 14, yielding something over three tons per acre. The fact that the plots at the station are exceedingly small must be kept in mind in considering these yields.

Legumes. The leading legume, as far as the extent of tests at the station is concerned, is alfalfa. This plant has been sown for several years at the station and has lived through the winter undoubtedly because of the certainty and sufficiency of the snow cover. In other parts of the Upper Peninsula alfalfa has lived through the winter and the areas of the alfalfa fields are increasing. Wherever it has been sown where a hardpan is near the surface or where sown with a nurse crop failures are reported. Again, the small size of the plots prevents the report of reliable data in the comparison of different varieties of alfalfa or of crops growing from seed from definite sources. The German alfalfa or the crop from imported seed seems to have done as well at the station as the American grown seed. The Turkestan gives the smallest yield of any of the alfalfas tried in the year 1904.

In the spring of 1905 it was noted that the crowns of the alfalfa seem to have been smothered out in the winter and the roots are sending up new shoots from below the crown. This makes the stand apparently very thin and heavy crops cannot be expected.

A European legume called Sanfoin gives some promise after three or four years trial.

June Clover. It has not required the work of the experiment station to show that on all clay loams and clays of the Upper Peninsula June clover is very certain to yield a heavy crop. Alsike clover belongs to the same list. The climate and soil are of the type which the clovers demand. The sole drawback seems to be the wet harvests.

Certain other legumes like the chick pea will require a good deal of observation before they are recommended. The lupines, both white and blue, make a luxuriant growth and display a hardiness almost equal to clover. The cow peas did not get far enough along to blossom. The soy beans were planted June 7 and blossomed August 7, setting a large number of pods with beans in various stages of growth. None approached ripeness. In 1903 the Ito San and the Ogemaw blossomed as early as August 22 and although no seed ripened, still the pods were well filled. Several other varieties of soy beans grew to a height of 30 inches to 36 inches, but did not ripen seed.

The vetches did not ripen seed and hence there seems to be little danger of the plant becoming a weed in the Upper Peninsula. In 1904

they were still in blossom at the beginning of November and some vines had reached a height of 12 feet. Superintendent Geismar recommends the plant as a weed destroyer.

Lathyrus ochrus was planted June first in 1903 and ripened late in August.

MISCELLANEOUS CROPS.

Buckwheat has ripened on successive years and is a safe crop for the Upper Peninsula. It is a little difficult to handle at harvest time because of adverse weather.

Field peas make an enormous growth, sometimes 11 to 13 feet. The work of the station is directed toward securing varieties that give an early harvest with a less growth of vines.

Flax ripens its seed and there is no reason evident why the Upper Peninsula should not in time produce an abundance of this crop for seed and for fiber.

The station has developed the plan of planting potatoes in the fall, relying upon the continuous covering of deep snow to protect the seed from freezing. No great advantage in yield is found by adopting this method but the crop is considerably earlier. Level culture is practiced. Of the varieties of potatoes the Sir Walter Raleigh has, on the whole, proved the best.

Sugar beets have made a good yield in the several consecutive years and the per cent of sugar has been high. A sugar factory has been erected at Menominee and the station has investigated the possibility of growing beets in the middle or northern parts of the peninsula. No reason is apparent why beets of high sugar content should not be produced on all of the clay loams of that peninsula.

Carrots, rutabagas, mangolds, table beets, all reach perfection at the Upper Peninsula Station in quality and in yield. The crops at Chatham are not surpassed in any part of the State.

GARDEN VEGETABLES.

A dozen varieties of snap and string beans were tried in 1904, all of them ripening and none of them suffering from disease.

Sweet corn reached the edible stage but did not ripen. Many varieties of cucumbers planted in the early spring were killed by a frost on September 22 in 1904. They had grown, however, a good crop of pickles prior to that time. Tomatoes did not ripen though the vines reached a good height and were heavily loaded with fruit when killed by the frost of September 22. Cabbage developed good hard heads and gave a very satisfactory yield. Onions were practically destroyed by maggots in 1904, that pest having spread rapidly over some parts of the Upper Peninsula.

A host of other garden vegetables and miscellaneous ornamental and useful crops were tested in the two years but results of importance have not yet been reached.

Strawberries have been grown since the station was started. The standard kinds ripen their fruit in great abundance at the station, even though the environment has not been altogether favorable. The late frosts have been the worst enemy.

THE ORCHARD.

Apples. Russian varieties have been tested. Seven varieties ripened fruit in 1904, the Haas, Borovinka, Gideon, Hiberna, Patten Greening, Yellow Transparent and Duchess. High winds have been not uncommon and have done considerable damage to the trees. Spraying has kept back the apple scab and good care has secured a good growth. The winters are severe. The trees are not damaged below the snow line, but above that, many varieties are injured on the south side, evidently from the bright sun reflected over the snow. This damage occurs in late December or early January or at any period in the winter when zero weather and high temperature sharply succeed each other. Some varieties like the Mann, Wagener, Boskoop and Canada Red were seriously damaged.

In 1904 most of the varieties of grapes made a growth of six or eight feet, but the fruit, although colored, failed to ripen properly.

Cherry trees are particularly susceptible to the damage from high winds and the late frosts. A disease is also attacking some of them below the surface of the ground where the scion was grafted into the root. The tops and the roots seemed to be fairly healthy but there was a zone of dead bark and dead tissue surrounding this junction of graft and root. The cause and nature of this disease has not been determined.

It seems to be fairly well determined from the investigations thus far carried on at the station, that the sour cherries, the hardier pears and the Russian apples may be grown with comparative certainty in the upper peninsula and that that section of the State will not be deprived of fruit of its own growing. Peaches are, of course, excluded, while plums are injured by the deep snow and the high winds. All sorts of root crops and nearly all garden vegetables common to the southern peninsula do well in the central part of the upper peninsula. Of the field crops corn must be dropped from the list for this region, while fall wheat will be grown at great risk. It is safe to say in conclusion that the possible crops for the northern part of Michigan constitute so large a list that the farmer will have no difficulty in securing a profitable and satisfactory rotation.

Mr. Leo M. Geismar has been the able superintendent of the sub-station since its beginning. He has not contented himself with the planning and carrying forward of experiments of great value, but has exercised a dominant influence on the upbuilding of agriculture in the upper peninsula by lectures at meetings of farmers and by frequent, valuable and inspiring contributions to the rural press.

BULLETIN 227

JUNE, 1905

MICHIGAN
STATE AGRICULTURAL COLLEGE
EXPERIMENT STATION

FARM DEPARTMENT.

LEGUMES OTHER THAN ALFALFA

BY

C. D. SMITH.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

The Station

MICHIGAN AGRICULTURAL EXPERIMENT STATION

Postoffice and Telegraph Address, - - - - Agricultural College, Mich.
 Railroad and Express Address, - - - - Lansing, Mich.

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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County 160 acres deeded.

LEGUMES OTHER THAN ALFALFA.

C. D. SMITH.

Summary.

1. Of the multitude of leguminous plants of economic importance, the following were tried on small plots: White lupines, sand lupines, gorse, sweet clover, fenugrec, kidney vetch, goat's rue, *Astragalus sinensis*, seradella, sulla, sanfoin, peanuts, goobers, giant beggar weed, Japan clover, *Cicer arietinum*, lentils, lathyrus and the vetches.

Of this list the following indicated some value as green manures, especially on sandy soils: the lupines, kidney vetch, goat's rue, crimson clover and the vetches, while the following gave some promise as a food supply for stock: crimson clover, seradella, sanfoin and Japan clover. For various reasons the following indicated no value for Michigan: sweet clover, fenugrec, *Astragalus sinensis*, sulla, peanuts, goobers, *Cicer arietinum*, lentils.

2. Tests carried on since the publication of a former bulletin confirmed the opinion that lathyrus silvestris is of little value either as a fodder plant or for green manure.

3. Among the varieties of cowpeas, these are recommended for such Michigan farmers as need them to plow under to enrich the soil in nitrogen: the Iron, the New Era, Whippoorwill and Blackeye. They must be planted late in the spring when the ground is fairly warm as they do not grow well in cool weather. They do not develop ripe seed except in unusually warm seasons, with frosts late in the fall.

4. Soy beans are now grown in all parts of Michigan. The tests discriminate between varieties designed to produce abundant forage and those bred to produce abundant seed. Of the former the medium green, early black, and yellow are leading sorts, of the latter the Ogemau, the rather small Ito San, and government 9413 are good types. The plots were too small to make the experiments, comparing varieties, of great weight.

5. The hairy vetch has been grown at the station for a good many years. It has been used as a green manure and as a forage crop. It has not been a success in the latter capacity. Sheep were hurdled on the vetch but would not eat it. It was then tried as a soiling crop but neither cattle nor sheep seem fond of it. It was cured as hay but again the stock refused it.

There are sold in the markets a great many species of vetch seed under the name of winter vetch, hairy vetch or villous vetch. The results of a comparative trials of these vetches at the station show that at least eight of them produce but a small amount of green forage, although they ripen abundant seed. Of these the *Vicia picta* was a fair sample, flowering in early July and fruiting in the middle of August.

On the other hand the *V. canadensis*, *angustifolia* and *peregrina* were three vetches that yielded abundant foliage and fewer seed. *V. disperma*

showed relatively few seeds but a great quantity of matted leaves and stems, supplying a dense mass of succulent green. Finally the *biennis*, the Louisiana vetch, the *gerardii* and *globosa* have showy, red or blue flowers and furnish a tangled and heavy mass of green forage. The horse bean, as the *V. faba* is generally called, is totally unsuited to Michigan climate, although of great value in England.

Professor B. O. Longyear suggests an analytical key which may aid in properly locating a new vetch.

Farmers are warned that the vetch has become a weed difficult to exterminate on the College farm and elsewhere.

6. Small areas of medium green soys, Ogemaw soys, New Era cowpeas, the *Vicia globosa*, second crop June clover and new seeding June clover were dug about and the soil washed away leaving the roots attached to the stems. They were separated into roots and forage at approximately the point where the knife or the mower would have cut at harvest and were separately weighed and analyzed. Combining the different factors and estimating the normal yield of forage per acre, it was found that the medium green soy yielded 152.29 pounds of nitrogen per acre, the cowpeas 61.90 pounds, the vetch 77.10 pounds, the second crop clover 51.47 pounds and the new seeding clover 49.06 pounds.

A later experiment in which soy beans and cowpeas were sown side by side to compare their values as green manure with that of buckwheat, the yields indicated a rather greater value to the soy beans as the analyses given above would suggest.

THE EXPERIMENTS.

In 1903, under the supervision of Mr. Bronson Barlow, now of the Ontario Agricultural College, Guelph, Ontario, an extended series of observations was made on a long list of legumes, some of them common and others rare, to determine which should be selected for farther investigation. Naturally most of these legumes are but illy adapted to Michigan conditions but it was decided to test them all that some information might be gained. The report is given in Mr. Barlow's language.

Lupinus albus, Linn., White Lupine. Planted May 15th, flowers July 1st to July 18th, fruit July 21st, fruit ripe and stems leafless August 19th, 36 inches high July 22d. It grows rapidly and produces a large bulk of green matter to be plowed under on sandy ground. It may be fed before coming into bloom. It has not been injured by blister beetle this season.

Lupinus termis, Forsk., received from Cairo, Egypt. Planted June 12th, grew well and was 16 inches high July 22d, 34 inches high August 19th, in full bloom August 19th, fruit matured slowly but some seed ripened in the fall. It is an attractive plant and compares well with *L. albus*. Its season is longer and for seed it should be planted by the middle of May.

Ulex, Linn., Gorse. Planted May 15th, 12 inches high August 19th. no flowers this first year, promises to endure the winter, has grown slowly, but is thrifty. It is a shrubby plant with spiny leaves. In Wales horses are often kept through the winter on Gorse. In England the farmers use it for fuel and for building rough shelters for sheep and cattle. For this purpose they cut it and tie it into fagots.

Lupinus arboreus, Linn., Sand Lupine. Planted June 12th, grew slowly, 4 inches high July 22d, 12 inches high August 19th, flowers yellow August 19th to September 27th, fruit formed slowly and some seed matured. This lupine did not thrive. It seems to have been too wet.

Trifolium incarnatum, Linn., Crimson Clover. Crimson clover, planted May 15th, flowers and fruit by August 19th and until September 27th, 12 inches high July 22d, 20 to 24 inches high August 19th, affected with a fungous disease, remains green under the snow.

It is said that in the mountains of West Virginia they sow crimson clover when they cultivate the corn ground for the last time in summer, and the next spring plow under the crimson clover before planting corn again. By this method they raise corn every year and still maintain the fertility of the soil.

Melilotus alba, Desr., Sweet Clover. The young plants were transplanted to this plot June 20th. By August 19th they were 36 inches high, and bushy. They did not bloom and died down to the ground in fall. Sweet clover is a troublesome weed along roadsides.

Trigonella foenum-graecum, Linn., Fenugrec. Planted May 15th, flowers June 21st to August, fruit is ripe July 22d, mostly dead August 19th, seed germinated in pods September 25th and the young plants grew until snowed under. The seed is used in condition powders. It is not of value as a forage plant in Michigan.

Anthyllis vulneraria, Linn., Kidney Vetch. Planted July 7th, 1 inch high August 19th, no flowers. It grew slowly as it does the first year. It may be tried on soil too sandy and barren for clover.

Galega officinalis, Linn., Goat's Rue. Planted May 15th, flowers July 24th to September 27th, fruit September 27th, 14 inches high July 22d, 24 inches high August 19th. Remaining green below under the snow. It will grow in sand and it resists drought. We have better plants for the better class of our soils. Stock has to learn to like it.

Astragalus sincensis, Early variety, Japan. Planted May 15th, 4 inches high July 27th, 4 inches high August 19th, dying. A dwarf, densely tufted plant. It did not thrive but declined and died. The roots did not appear normal.

Astragalus sincensis, Late variety, Japan. Notes as for the above, a few violet red flowers in threes at the summit of scape-like peduncles appeared late in July then plants declined and died.

Ornithopus sativus, Brot., Seradella. Planted July 7th, up July 20th, 2 inches high August 19th, first flower September 27th. No fruit. This should be planted in May, it grew well in the fall but had not time enough. It remains green under the snow. It might be made useful on our pine stump lands, however, no nodules formed on these plants.

Hedysarum coronarium, Linn., Sulla. Late variety received from Malta, July, 1901. Planted June 20th. Germinated and grew slowly, 2 inches high July 27th, 6 inches high August 19th. Did not bloom. It is of no use here for it should grow 4 to 6 feet high. Our winter weather freezes it.

Onobrychis sativa, Ian., Sanfoin. Giving two cuttings of hay per season, received from France, September, 1901.

Planted June 12th, flowered August 10th to September 27th. Fruit September 27th, 3 inches high July 22d, 7 inches high August 19th, flower stems 12 inches high.

These plants are well established which is all that could be expected the first year. There are sandy hills in Michigan which are cropped with small profit or remain unused which should produce sanfoin hay year after year with little trouble after they are once planted with it.

Arachys hypogea, Linn., Peanut. Planted May 21st, first flowers July 13th, a few fruits matured. Vines 5 inches high July 22d. Michigan climate is too cold for peanuts.

Voandzea subterranea. African Goober. Planted May 31st, yellow flowers August 14th until frost, plant 5 to 6 inches high. Of no use in Michigan. No fruit matured.

Desmodium tortuosum, D. C., Giant beggar weed. Planted May 15th, flowered September 2d to September 27th, 8 inches high July 22d, 24 inches high August 19th, 36 inches high before killed by frost. Climate is too cold for it, a few fruits formed.

Lespedeza striata, Hook., Japan Clover. Planted May 15th, no flowers, 3 inches high July 22d, 5 inches August 19th, a fine densely tufted growth. It is sensitive to frost and was killed in the fall. It is not hardy enough for Michigan. Dodder attacked this plant but did little harm.

Lespedeza bicolor, Turez., from Japan. Planted May 15th, 10 inches high July 22d, 15 to 22 inches high August 19th, reached 36 inches before killed by frosts in the fall, no flowers. The climate is too cold and the season too short.

Cicer arietinum, Linn., Gran. Planted May 15th, flowers July 2d until frost, 24 inches high August 19th, fruit matured September 27th. It endures light frost. Though this plant grew vigorously no nodules were found at any time on its roots. It is grown in India for its seeds, but our climate is hardly hot enough.

Ervum lens hiemale, red winter lentil. Received from France, September 19th, planted June 12, first flowers August 19th; five inches high July 22d, 7 inches, August 19th. It continued long in bloom but set no fruit, it kept green all the fall and is green under the snow.

Ervum lens, Linn., Lentil. Planted May 15th, flowered July 1st, continued with flowers and fruit to August 19th, died in fall; 12 inches high July 22d, 12 to 16 inches, August 19th. These plants produce little green matter and in this climate they do not fruit freely. They are of no practical value here.

Vicia orobus, D. C., from Crete. Planted June 12th; flowers, July 17th; flowers and fruit, August 19th; 6 inches high July 22d; 12 inches high August 19th; like *Ervum lens* but decidedly better as it remains very green from spring to winter. It also fruits freely, having 4 seeds in a pod.

Pisum sativum, Linn., Blackeye Marrowfat Pea. Planted May 21st, flowers July 13th to August 19th; ripe fruit August 19th. Vines 39 inches long July 22d; the tangle of vines 24 inches high, August 19th; equal in growth to the field pea and seed more valuable.

Pisum sativum, Linn., Field Pea. Same as above but vines 30 inches long; field peas are much grown in this state and are especially valuable for the northern portion. Some farmers sow peas with oats for cows or with rape for hogs.

Lathyrus sativus, Linn., Seed from Moscow, Russia, June, 1898. Planted June 12th, first flowers July 21st; 10 inches high July 22d;

stems 24 inches long August 19th. Continued in bloom until September 27th; a little fruit matured.

Lathyrus ochrus, D. C. Received from France, September, 1901. Planted June 12th, grew slowly at first, 3 inches high July 22d, stems 8 inches long August 19th, flowers September 13th, no fruit was observed to mature. It forms a dense tangled growth which remains tender and green throughout the season. It is very hardy, remaining green under the snow. Perhaps no other species produce so large a weight of nodules. It is a promising species.

The Winter Flat Pea, *L. cicer*, Habl., was planted with rye on June 12th. It grew but showed no flowers up to the 19th of August, when it was 12 inches high. It remained green through the season and under the snow.

Lathyrus silvestris, flat peas. An early bulletin, in 1892, reported the yield and habit of growth of this importation from Germany. In 1895 and 1896 a great deal of attention was paid to the crop. The season of 1896 was damp and the crop was luxuriant. On June 29th one acre was measured off and on this and the two following days the crop was cut and weighed as fast as it could be hauled to the scales. The total product from the acre in the green state was 12 tons. The cured hay weighed 5,431 pounds. On September 16th following, the same acre was cut giving a yield of 3,636 pounds, or a little over one and three-fourths tons. The total yield of hay from the acre was four and a half tons. When it was attempted to feed this *Lathyrus* hay to stock it was found that the latter had to be starved to eat it at all. Sheep were pastured on the green alfalfa but refused to eat it in sufficient quantity to sustain life. These facts, combined with the further one that the seed is extremely expensive and very slow to germinate and grow, makes the verdict of the station against the use of the flat pea for any purpose whatever on the ordinary Michigan farm.

At the conclusion of Mr. Barlow's work on the small plots it was decided to confine the future investigation very largely to soy beans, cowpeas and hairy vetch. The tests of soy beans and cowpeas were carried on, in 1903, on the series of station plots known as 33 to 71. The ground is level, thoroughly underdrained, clay loam. The seed was drilled in May 28th in rows 18 inches apart, the length of the rows, 8 rods. They were drilled in the following order, beginning at the west:

COWPEAS.

	Rows.	Lbs. Seed.
Chinese Red, No. 979.....	4	.....
Down's Early, No. 1090.....	11	.....
Unknown.....	11	.....
Sherman's Northern Prolific.....	22	2.25
Iron.....	22	3.8
Taylor.....	22	4
Whippoorwill.....	22	3.75
Black Early.....	22	4.2
New Era.....	22	4.25
Browneye.....	22	3.5
Blackeye.....	22	4.75

SOY BEANS.

	Rows.	Lbs. Seed.
Early Black, Michigan grown.....	22	3.75
Medium Green, Michigan grown.....	22	5
Ogemaw, Michigan grown.....	22	4.5
Ito San, Michigan grown.....	22	3.5
*9413, Department of Agriculture.....	22	4
9410, Department of Agriculture.....	22	3.75
9411, Department of Agriculture.....	22	3.06
8423, Department of Agriculture.....	11	1.25
9407, Department of Agriculture.....	11	1.75
9409, Department of Agriculture.....	22	6
Extra Early Black.....	22	3
Medium Green.....	22	3.2
Ito San.....	22	3.25
Yellow.....	22	4.25
Wood's.....	22	3.88
Medium Green, Selected, 3 ft. rows.....	12	
9409, 3 ft. rows.....	9	

The season was very wet and cool, greatly hindering the germination and growth. They were cultivated and hoed late in June and in early July. By the latter part of July the soy beans were in bloom and too large to cultivate. Other notes follow:

August 18. The Chinese red cowpeas, No. 979, were 12 inches high and carried buds nearly ready to blossom. All other varieties of cowpeas carried buds and measured in height as follows: Down's Early, 8 inches; Unknown, 8 inches; Northern Prolific, 8 inches; Iron, 14 inches; Taylor, 9 inches; Whippoorwill, 13 inches; Black Early, 13 inches; New Era, 10 inches; Browneye, 10 inches; Blackeye, 15 inches.

Of these varieties the Iron began to show considerable superiority by the middle of August, the Blackeye appeared to be next in quantity of foliage and in general thrift. Part of the seed, although showing no less a per cent of germination seemed to have been improperly stored or injured in some other way, making the stand of that variety defective. This statement is true of the Taylor, the Down's Early, the Unknown and the Northern Prolific.

On the 18th of August the height of the soys and the condition of bloom was as follows: Early Black, 30 inches and past bloom, the pods already carrying immature seed; Medium Green, 36 inches in full bloom; Ogemaw, 32 inches, well podded, two to three beans in a pod; Ito San, 28 inches, in bloom and podded; 9413, 27 inches, in bloom, poor stand; 9410, 30 inches, just coming into bloom, poor stand; 9411, 10 inches, just going out of bloom, very small, stand very poor; 9407, 28 inches, in full bloom; 9409, 24 inches, coming into bloom; Extra Early Black, 24 inches, past bloom, well supplied with pods; Medium Green, 36 inches, in bloom; Ito San, 30 inches, in bloom with small pods; Yellow, 22 inches, not yet in bloom; Wood's, 24 inches, not yet in bloom.

On the 14th of September the Early Black was loaded with pods which were ripening. The leaves were dropping off. The Medium Green pods were filling well, the stalks green and vigorous. On the same date the Ogemaw had ripened its seed fully, the beans were hard and nearly all of the leaves dropped away from the stalks. The Ito San showed a greater number of pods but was not quite so ripe as the Ogemaw.

On the 24th of September most of the soy beans and all of the cowpeas except some specimen plants left to test the influence of frost, were harvested. None of the varieties of cowpeas gave any indication of ripening before frost. The early black soy, the Ogemaw and the Ito

San were ripe, the leaves dead leaving the branches and abundant pods exposed. The medium green soy had made a dense growth and stood up nearly 3 feet high bearing large numbers of pods not yet mature. Of the varieties sent by the government for tests, 9413 was left uncut because bearing an abundant harvest far enough advanced to allow hope of ripening. 9410 was cut. It had quite a few pods but they were too small and too immature to allow hope for any ripe beans. 9411 had a poor stand, the plants were small but well podded and nearly ripe. 8423 had a very poor stand and at this late date was still in blossom. 9407 seemed to have a fairly good stand and produced an abundance of pods too small to mature this season. 9409 had a good stand but was too late a variety for this climate, just going out of blossom on the 24th of September. The early black, not Michigan grown, were not as well matured as those grown from seed produced in this State.

On the 15th of October the 9413 and the medium green were well advanced toward maturity.

September 24th was followed by ten days of continuous rain. The legumes cut on that date were at no time dry enough to haul to the barn until October 10th. They had to be turned frequently to prevent spoiling and the weights given below must be considered with this fact in mind:

Variety.	No. rows.	Yield.	
		Lbs. per plot.	Lbs. per acre.
Chinese Red, not harvested.			
Downs' Early, No. 1090.	11	29	580
Unknown	11	43	860
Northern Prolific.	22	48	480
Iron	22	130	1,300
Taylor	22	54	540
Whippoorwill	22	58	580
Black Early	22	96	960
New Era	22	150	1,500
Browneye	22	65	650
Blackeye	22	99	990
Soy Beans:			
9410	22	286	2,860
8423	11	53	1,060
9407	11	105	2,100
9409	22	395	3,950
Yellow	22	105	1,050
Wood's	22	279	2,790

The following varieties were harvested for seed October 24th. The table gives the yield of grain and straw:

Variety.	Rows.	Yield per acre.			
		Grain. Lbs.		Straw. Lbs.	
Early Black	22	830		1,600	
Ogemaw	22	570		1,120	
Medium Green	22	700		2,500	
Medium Green	22	970		2,650	
Medium Green, selected		610		1,200	
9413	22	510		1,850	
9411	22	100		190	
Ito San	22	860		2,450	
Ito San	22	610		2,350	
Early Black	22	440		800	

On the evening of September 28th a frost occurred. All varieties of soy beans and cowpeas seemed to be equally affected by it. Again, on the 15th of October, after a heavy frost of the night before, the medium green soys being more succulent showed the greater effects of the cold weather.

The plots devoted to variety tests in 1904 were in A, east of a large grain barn, which partly protected them from severe west and south-west winds. The soil is a clay loam of varying character, changing to a very sandy loam at the east end of the plots and merging into a stiff clay toward the south side of the series. The plots were 18 rods long and for the most part 1 rod wide. The ground was plowed on May 16 and 17 and harrowed. It was again harrowed, rolled and thoroughly prepared on May 28 and 30. The plots ran east and west. The varieties tested were sown in the following order on June 1, the plots being numbered from the north:

- Plot 1, Medium Green;
- " 2, Ogemaw;
- " 3, Early Black;
- " 4, 9413, from U. S. Dept.

Four rows each of Ito San, Gosha, Rukigira, Rukugetsue follow next in order. On June 6 the soy beans were beginning to show a good stand. They were cultivated on June 13, 15, 22 and 28 and on July 6 and 8. They were hoed on June 15 and July 8. By July 9 the medium green soys were 11 inches high, were much darker in color than the Ogemaw and with a distinctly coarser and more hairy stem. The Ogemaws were a foot high, a little lighter colored and more delicate in appearance. The early blacks averaged 11 inches in height, the Ito San 11 inches and the Gosha 11 inches. The latter had peculiarly light colored, velvety leaves and gave a good indication at that date of being a distinctly early variety as did the Ito San. The Rukigiri and Rukugetsue gave no evidence of superiority over the rather better known and more standard varieties.

On July 21, the Ogemaw soys were in blossom and were 2 feet in height. The Ito San from northern grown seed, was also in blossom. The next day the extra early black began to show blossoms and on July 23 the early blacks came in bloom. The government 9413 did not show blossoms until July 30 and the medium green not until August 4.

By August 29 the medium green soys had full sized pods with the beans just nicely starting to develop, while the Ogemaws contained in the pods beans almost fully grown, and beginning to ripen. The early blacks were not as far along at this date as were the Ogemaws and the government 9413 were at about the same stage as the medium green. The Ito San seemed about half grown, the Gosha with pods full size and beans one-third size. The extra early black showed pods fully developed.

By September 2 the Ogemaw soys were ready to harvest with the leaves nearly all shed. The early black was not quite so far advanced as the Ogemaw and the Ito San had half of the leaves fallen with pods partly ripe. The Gosha was beginning to ripen, some leaves having fallen. This variety was not so heavily podded as were the three others just mentioned.

The beans were harvested on October 10 by pulling and were left on the ground until the 17th and 18th when they were hauled to the barn. The gross weight of the entire plant was as follows, being the yield of a rod wide by 18 rods in length:

Medium green, 79 pounds; Ogemaw, 42.5 pounds; early black, 67 pounds; government 9413, 26 pounds; Ito San, 33 pounds.

On a separate area the medium green variety was grown for silage. It was harvested on September 29, yielding, green weight, 8,800 pounds per acre.

The variety tests of cowpeas in 1904 were conducted on series H of the station plots. The season was peculiarly unfitted for this semi-tropical crop and none of the varieties ripened much seed. Notes were made of the peculiarities of the different varieties although they did not mature enough to warrant a record of the weights at harvest. The Missouri, Taylor, Clay, Iron, Wonderful, Whippoorwill and New Era attained a height of over 15 inches, the Missouri and Clay leading in this respect. The date of the first blossoming was August 18 for the Whippoorwill, Michigan Favorite, and Early Blackeye. The New Era, Black and Unknown began to blossom August 27; the Taylor, Sherman's Northern Prolific, Down's Early, the Iron, the Rice, the Red Ripper, the Clay and the Wonderful began blossoming in mid-September or a little later, the Rice, the Missouri and the Wonderful being the last to blossom. The Michigan Favorite, Early Blackeye and Missouri have long tendrils, the Whippoorwill, the Wonderful, the New Era, Black, Clay, Unknown, Red Ripper, Taylor, Rice, the Down's Early and Iron, have no tendrils. The Clay and Taylor were very upright; the New Era, Iron, Missouri, Whippoorwill and Michigan Favorite were fairly upright although the last was a little inclined to sprawl upon the ground as were the Wonderful and the New Era. The Black made no attempt to stand up but was very spreading and recumbent; the Unknown, the Red Ripper, the Early Blackeye, Rice, the Northern Prolific and Down's Early were spreading, lodged and prostrate.

On the 11th of September one square rod was measured on the plots devoted to the following cowpeas, the yield of the square rod, weighed green, is reported below:

Wonderful,	56	pounds.
Whippoorwill,	40	"
New Era,	26	"
Red Ripper,	23	"
Black,	20	"
Clay,	37	"

In the spring of 1905 a square rod of the Whippoorwill variety was harvested, the leaves having fallen and disappeared, the stalks and part of the roots alone remaining. All of the stalks and roots on the square rod were gathered, weighed and analyzed. The weight of the stalks with roots attached was 13,375 pounds. The chemical analysis of these stalks showed the following results:

Water,	23.34	per cent.
Ash,	8.84	" "
Nitrogen,	1.23	" "
Potash, trace.		
Phosphoric acid,	.95	" "

A combination of this analysis and the weight on the square rod shows that the stems and attached roots of cowpeas left standing during the winter returns to the soil when plowed under, 26 pounds of nitrogen per acre.

HAIRY VETCH.

The station began the work with this crop in 1896, sowing a small area with oats, 25 pounds of vetch seed and 32 pounds of oats being used. The oats germinated so quickly and grew so rapidly that the vetches were not seen until the oats were harvested. On July 6 the oats and vetches were ready to cut, the oats being fully headed and ready to turn. Because the vetches had made such meager growth the harvesting of the crop was delayed until July 29, when the oats were fully ripe. The crop weighed, August 1, in rather damp condition, 2,132 pounds to the half acre. As soon as the oats were removed the vetches began to show themselves. They grew rapidly and completely covered the ground before the first of September. There was a severe frost on the 19th of that month which did not injure the vetches, though it stopped the growth of the second crop of sorghum on the adjacent plots. The attempt was made to feed the vetches to sheep but they refused to eat them until practically starved. They were hurdled on the vetches but would not eat them as pasture. Part of the plot was mowed and removed. On this part the vetches withstood the winter and were green in the spring of 1897, but where it was left unharvested the growth was so rank as to completely kill out, by smothering, all of the plants. The five square rods cut on November 12 furnished 430 pounds of green forage or at the rate of nearly seven tons per acre. Later in the season, after the frost had killed all other green stuff, the cows seemed to eat the green vetches with avidity and the sheep did not altogether discard them. The vetch is a slender plant, the stems usually trailing upon the ground and reaching a length of six to ten feet. Under the name of Hairy Vetch a great number of different sorts are sold in the market. In the spring of 1899 a large importation of vetch seed, supposed to be correctly named, was made and the seed sown and tested. It was found that the vetches going in American markets under the name of Hairy Vetch or Villous Vetch, included all kinds of vetches, some valuable and others entirely worthless, some with fine leaves, others with coarse, some bushy and erect, others recumbent, some covering the ground with a thick mat of vines, others giving but a sparse growth.

Vetches have been sown annually on the station plots since 1897. In the latter part of the bulletin, page 180, there is given a comparison of vetches and other legumes on the basis of their content of nitrogen, phosphoric acid and potash.

Complaint against the vetch having come to the station, an examination was made of a tract of country east of Howard City in Montcalm county. It was found that some vetch seed brought in some time prior to 1900, had been sown on farms of sandy loam soils. There was an enormous growth and the plants seemed so promising that the seed was distributed to many farmers in the neighborhood. Later it was discovered that the seed remained in the soil from year to year until conditions favorable to its growth obtained. On a single plant at the station over 1,000 seeds have been found. It is manifest, therefore, that where plants escaped the harvester and went to seed, the soil would be

fairly certain to become a reservoir for vetch seed from which undesired specimens would rise to plague the farmer when the field was sown to wheat. Millers refused to buy wheat from that section of the country, because so many fields were infested with the vetch, the seed of which is nearly the same in size as kernels of wheat and of the same specific gravity. Moreover, the flour from wheat with which vetch seed is mixed, is poor in quality and makes a sticky dough and are altogether undesirable loaf. It is but fair, therefore, to warn farmers against the sowing of vetch on fairly rich soils. On the station farm where this plot of vetch grew in 1895 no vetch has been sown since, yet whenever the field is sown to wheat the blue flowers of the vetch show themselves and it is necessary to send men ahead of the binder to pull up the plants to prevent damage to the wheat.

Among the varieties or species of vetches to be recommended the following are perhaps the leading ones. They are ranged in order of maturity of their fruit on the 20th of August, the one with the most ripe fruit being placed first. No common names of the vetches are known. They belong to the genus *Vicia*. In the notes below the name of the genus will be represented by *V.*, the name of the species following that letter.

The vetches were planted May 13.

V. picta, Fisch. Flowers July 5, fruit August 19, 14 inches high, dead before September 27.

V. calcarata, Deaf. Flowers July 5, fruit August 19, dead before September 27.

V. cordata, Wulf. Flowers July 5, fruit August 19, 15 inches high, August 19.

V. segetalis, Thurill. Flowers July 5, fruit and few flowers August 19, 17 inches high August 19.

V. cornigera, Chaub. Light pink flowers July 5, fruit ripe and some seeds germinating September 27.

V. ambigua, Guss. Flowers July 5, ripe fruit August 19, 16 inches high.

V. sativa, Linn. Planted May 13, flowers July 7, fruit and flowers August 19 and until September 27, 24 inches high August 19.

V. sativa typica, improved gray vetch, received from Svalof, Sweden, planted June 12, too late to compare with other vetches. It was in flower September 27.

The above vetches have short stems yielding a small bulk of green matter, maturing seed early and in abundance and afterwards turn brown and die.

Below are given the vetches that reverse these conditions more and more as we advance in the list.

V. canadensis, Zucc. Light pink flowers July 17, vines 48 inches long August 19, fruit September 27, a desirable vetch yielding well in hay or seed.

V. angustifolia, Linn. Smaller red flowers July 21, stems 24 inches long August 19, remaining green into the winter.

V. peregrina, Linn. Southern vetch, flowers July 8, abundant fruit and flowers August 19, 24 inches high August 19, ripe fruit and a few flowers September 27, an excellent species.

If vetch seed is desired, select from among the first on the above list. If a large yield of hay is wanted select from the last part of the list.

The vetches named below have finer leaves and stem, minute white to pink flowers, a few on each small peduncle, fruits very small, few seeded, the growth dense and matted.

V. disperma, D. C. Flowers July 7 to September 27, matted growth 36 inches high August 19, fruit not abundant but a very large quantity of succulent green matter.

V. argentinum, Guss. = *V. biconca*, Rafin. Flowers July 16, fruit August 19, growth 32 inches; does not fruit freely but produces a large bulk of green material.

V. hirsuta, S. F. Gray. Minute flowers July 8, flowers and fruit August 19 to September 27, 21 inches high August 19. This species fruits freely but produces less growth than the preceding.

The following vetches have abundant, showy, red, purple or blue flowers, one sided on long peduncles; rampant leafy vines, forming a tangled mass. They are given in the order of their growth, the largest first. Few of them fruited freely.

V. biennis, Linn. Flowers June 21 to September 27, 48 inches high August 19.

V. ludoviciana, Nutt. Flowers July 16 to September 27, 36 inches high August 16. This species gives a thick, heavy, dense mass of vegetation over the entire plot.

V. gerardii, Vill. Flowers before July 7 and until September 27, showy blue flowers, 36 inches high August 19.

V. globosa, Retz. Red flowers June 21 to September 27, young fruit August 19, 35 inches high August 19.

V. narbonensis, Linn. Planted June 22, too late to compare with the other varieties and species. Its dark red flowers were conspicuous July 29 through the season to September 27. Its fruit was nearly ripe September 27.

The vetch known as horse bean, *V. faba*, Linn., has been grown annually but is unsuited to Michigan climate and conditions. It is regularly attacked by plant lice and practically killed.

While many of the vetches resemble each other closely others vary widely in appearance. Prof. B. O. Longyear, then botanist of the station, made a somewhat careful study of the botanical characteristics of the species of vetches growing on the station plots and suggested the following analytical key as an aid in discriminating between the several species. This key is confessedly tentative but will aid in placing a new vetch in proper relation to known forms.

ANALYTICAL KEY TO VETCHES.

I. Stems erect, stout; leaflets large, few tendrils poorly developed; whole plant glabrous, becoming blackened where dried.

V. sativa dura.

V. faba.

V. narbonensis.

II. Stems spreading or climbing, slender; leaflets mostly small and numerous; tendrils well developed; plant more or less hairy or pubescent.

A. Stipules, especially the lower, with several prongs, with a reddish glandular spot; leaflets numerous, truncate or notched, mucronate; flowers 1-3, sessile or short stalked in axils of leaves, purple.

a. Stems and pods velvety, more or less robust; flowers three-fourths to one inch long.

1. Pods one-half inch or more wide, robust, *V. sativa typica*.

2. Pods one-third inch wide, *V. peregrina*.

3. Pods one-fourth inch wide, *V. cornigera*.

(These three species form a descending scale as regards size and hairiness with *V. Sativa typica* standing at the head.)

b. Mostly slender, sparingly pubescent; flowers usually less than three-fourths inch long.

1. Leaflets mostly obtuse-truncate at apex, *V. grandiflora*.

Leaflets oblong-linear, *V. angustifolia*.

Stipules large, margin lacerated, *V. canadensis*.

2. Leaflets mostly retuse or notched at apex.

*Stems and pods minutely pubescent, *V. segetalis*, *V. ambigua* (deeply notched).

**Stems and pods nearly or quite glabrous, *V. picta*, *V. Calcarata*, *V. cordata*.

B. Stipules conspicuous, with numerous prongs, glandular spot pale; leaflets few, about 2 pairs, ovate to narrowly elliptic, apex often acute; flowers 1—several on a lengthened peduncle, pale blue, *Vicia bithynica*.

C. Stipules simple or once pronged at base (half sagittate), not glandular spotted; leaflets numerous obtuse or acute, mucronate; flowers one-sided, racemose or spicate few or numerous on a lengthened peduncle.

a. Flowers numerous, conspicuous, deep purple, stems pubescent.

*Pods glabrous, flowers blue purple, *V. gerardii*.

**Pods hirsute or hairy.

†Stems, and especially the pods, quite strongly hirsute, *V. onobrychoides*.

††Stems and pods sparingly hirsute, *V. globosa*.

Flowers reddish purple, *V. biennis*.

b. Flowers few, inconspicuous, usually pale purple, stems nearly glabrous.

*Pods glabrous, *V. ludoviciana*.

**Pods minutely hirsute or hairy.

†Flowers 1—2 about one-half inch long; pods 4—6 seeded, *V. cassubica*.

††Flowers 3—6, about one-fourth inch long; pods 1—2 seeded. *V. disperma*.

V. argentinum.

Vicia bithynica, L. Stems low, angled, branching at base, sparingly silky, slender, green; leaflets 1—2 pairs, rather large, obovate—narrowly lanceolate, tapering at each end, apex mostly acute, mucronate, sparingly silky; stipules large and conspicuous, margin spreading and laciniate, glandular spot pale; flowers 1—2 on a somewhat lengthened peduncle, 6 to 8 inches long, bluish. Pods 5 inches wide, one and one-fourth long, flattened, hairy, seeds 4—5.

VETCH AS HAY.

In the fall of 1899 several sowings were made with a view to growing them for hay the following season. One lot sown September 5 was used for early soiling, beginning June 11 and continuing two weeks, during which time one-tenth acre produced 1,676 pounds green feed. Another plot sown the same date, September 5, on light sand, was cut for hay June 11, producing one crop of 4,188 pounds cured hay per acre. Another tenth acre sown October 5, at the rate of three pecks per acre, three parts Gold Coin wheat and two parts winter vetch, was harvested June 25, producing 3,016 pounds cured hay per acre. Another seeding of one peck of wheat and one peck of vetch per acre, made October 7, 1901, on sandy loam soil, was harvested June 22, producing 4,300 pounds cured hay per acre. Another similar mixture similarly treated, produced 4,000 pounds cured hay per acre. This hay is not altogether palatable but cattle will eat it either green or dry and this new legume may be sown late in the fall, with the expectation of securing a crop of hay the next season.

SOY BEANS AND OTHER LEGUMES AS GREEN MANURES.

It is difficult to compare legumes as to the amount of plant food they will add to the soil if used as green manures. A season that is best for clover may not be best for soy beans. Cowpeas are tender and if an early frost be a severe one, they are killed outright by this before completing their growth. Soy beans are adapted to clay loams and clay as well as to sandy loams, while cowpeas have done better at the station on sand and sandy loams. The vetches will grow on clay loam but seem to find a more congenial soil when planted in sandy loams.

On the 23d of September, 1903, there were growing plots of soy beans, cowpeas, vetches, new seeding clover and second crop clover. On soil not widely differing in physical character, the soy beans, cowpeas and clover had abundant nodules on the roots, the vetches had a few nodules but were not well inoculated. The varieties selected for comparison were the Medium Green soy, the New Era cowpea, the *Vicia globosa* and the June clover, not the Mammoth nor the Alsike. Another soy, the Ogemaw, was also examined and its composition is recorded below. Its roots were free from nodules. Of the two samples of clover, one was from a field from which the hay had been cut and removed July 2 and the second crop allowed to grow and the other from a field seeded in wheat in the spring of 1903, the wheat harvested July 15. All samples were taken September 23, 1903. The soy beans, cowpeas and vetches were in rows 18 inches apart. From one of these rows which in appearances, in height and in thrift, fairly represented the plot, there was removed 8 feet in length. This was done by digging a trench on each side of the row and 9 inches distant from it. The earth was then washed out or gently shaken out from the roots. As far as possible every rootlet was saved with all the nodules. This gave, of course, the total yield of foliage, stems, roots and nodules on 12 square feet. This material was taken to the laboratory and the forage separated from the roots at the point where the knife of the mower would have cut at haying. The forage and roots were then separately weighed and separately analyzed.

To secure a sample of clover to compare with the soy beans, cowpeas and vetches, an area 8 feet long by 18 inches wide was surrounded by a trench and the clover roots carefully removed and freed from adherent soil by shaking gently and by washing. The samples of clover were then divided into forage and roots just above the crown and were weighed and analyzed. The depth to which roots were taken in each case was 8 inches. The weights of the forage and roots on the 12 square feet of the several legumes were as follows:

Legume.	Forage. Lbs.	Roots. Lbs.
Medium green soy	5.125	.454
Ogemaw soy	1.69	.25
New Era cowpeas	3.94	.319
Vicia globosa.....	1.25	.125
June clover, second crop	1.5	1.44
Clover, new seeding	4.625	.75

The results of the analyses of the above material are set forth in the following table, the per cent of ash, protein, nitrogen, phosphoric acid and potash being the parts per hundred of dry substance and not the per cents of total weight:

Legume.	Water.	Organic matter, per cent.	Ash, per cent.	Protein, per cent.	Nitrogen, per cent.	Phosphoric acid, per cent.	Potash, per cent.
Medium Green soy:							
Forage.....	76.56	91.14	8.86	18.53	2.97	.55	1.98
Roots.....	72.56	93.42	6.58	6.92	1.11	.35	.87
Nodules.....	51.15			26.19	4.19		2.05
Ogemaw soy:							
Forage.....	53.55	85.10	14.90	12.88	2.06	.80	1.20
Roots.....	74.90	94.34	5.66	5.07	.81	.36	.90
New Era cowpeas							
Forage.....	84.13	86.80	13.20	14.50	2.32	.51	2.92
Roots.....	60.36	91.36	8.64	7.44	1.19	.67	1.94
Nodules.....	70.23			24.39	3.90	.96	
Vicia globosa:							
Forage.....	60.00	90.56	9.44	18.19	2.91	.68	2.38
Roots.....	50.00	94.21	5.79	15.13	2.42	.75	
June clover, 2d crop							
Forage.....	50.00	90.52	9.48	10.87	1.74	.34	1.30
Roots.....	60.80			13.13	2.10	.55	1.28
Clover, new seeding							
Forage.....	78.33	91.34	8.66	15.42	2.47	.67	3.39
Roots.....	77.94	89.54	10.46	13.54	2.17		2.00

Since the table gives the proportions of the different constituents in per cents of dry matter, they are directly comparable. It is to be noted that the per cent of nitrogen in the dry matter of the forage of soy beans, cowpeas, vetches and new seeding clover, does not widely differ. The nitrogen in the nodules of the soy beans and cowpeas is practically four per cent of the dry matter, while the nitrogen in the roots is approximately one per cent where the nodules have been removed and over two per cent where the nodules were analyzed with the roots, as was the case with the clovers and the vetch. The per cent of potash in the forage of the clover, scarcely five months old from the seed, is significant. It is more than twice as high as in the dry matter of the forage of the second crop of clover.

The weights of forage and roots made when the samples were taken, gives the relation between the weight of forage and roots. It is possible, therefore, to construct the next table which gives the amount of nitrogen, phosphoric acid and potash in a ton of the dry matter of the forage and the roots which accompanies that quantity of forage. In other words, using a ton of the dry matter of the given legume as a basis, the amount of green forage is calculated; thereafter, the number of pounds of roots which naturally accompanies this quantity of forage is calculated and its content of nitrogen, phosphoric acid and potash added to the amount of these materials in the forage. The sums are set forth in the following table:

Legume.	Nitrogen, lbs.	Phosphoric acid, lbs.	Potash, lbs.
Medium green soy	64.97	11.68	43.04
Ogemaw soy	42.41	16.55	25.39
Cowpeas	52.98	13.23	67.09
Vetch	64.25	15.48	52.60
Second crop clover	64.34	15.06	45.22
Clover, new seeding	56.52	13.38	74.38

This table seems to show that in a ton of the dry matter of the legumes known to be inoculated, there is something over 64 pounds of nitrogen in the medium green soy, the vetch and the second crop clover. The new seeding clover and the cowpeas fall somewhat behind, while the Ogemaw soy, perhaps largely because at the date harvested, the variety had lost some of its leaves and was not inoculated, returns but 42.41 pounds of nitrogen in a ton of dry matter of the forage with the roots and nodules accompanying.

Were it possible to determine what an average crop of the several legumes under study really was, it would be interesting to compare the amount of nitrogen, phosphoric acid and potash supplied per acre by these plants used as green manure. An attempt to do this is made in the next table. The yields of the soy bean on acre areas on the college farm is known. The per cent of water in the hay was 20 per cent and the yield 5,860 pounds. The cowpeas yielded much less, the average being approximately 3,575 pounds of hay, 20 per cent water. The yields of the vetch were estimated from several square rods measured and weighed. The green crop of the *V. globosa* used in the experiment was approximately 8 tons per acre, with the per cent of water given in the former table.

In this particular year the new seeding of clover was very heavy. After the wheat was cut off July 15 the growth was fairly rank, so much so that the crop had to be cut and carried off the field to prevent smothering during the following winter. The approximate yields were, for the second crop clover, one ton per acre and for the new seeding 2,170 pounds of hay, 20 per cent moisture. It is not assumed that the yields given are typical or that they fairly represent the average yields of these crops over the State. Taking these yields as a basis and adding to the fertilizing ingredients in the forage the amounts that would be found in the weight of roots going with that amount of forage, the following table is constructed to show the amount of nitrogen, phosphoric acid and potash that would be supplied to the soil by the amounts of hay of the several legumes mentioned were the entire plants plowed under:

Legume.	Hay, lbs.	Nitrogen, lbs.	Phosphoric acid, lbs.	Potash, lbs.
Medium green soy	5,860	152.29	27.38	100.89
Ogemaw soy	3,480	59.03	23.04	29.34
Cowpeas	3,575	61.90	15.45	77.20
Vetch	3,000	77.10	18.58	63.12
Second crop, clover.....	2,000	51.47	12.05	36.18
Clover, new seeding....	2,170	49.06	11.61	63.55

If these crops are plowed under it must be remembered that the nitrogen is in organic form and will be available for subsequent crops very slowly. Bacteria must work upon the organic matter, digest and, by the decay, reduce the nitrogen to nitrate form. The other ingredients will also be inert and useless to crops until the organic matter shall have decomposed. This fact gives to the green manure plowed under certain advantages and certain disadvantages. The plant food thus added to the soil is not readily washed out and the humus formed from it besides supplying slowly needed plant food adds to the water-holding capacity of the soil. What proportion of the nitrogen is lost in fermentation and the subsequent changes into humus and finally into nitrate is not definitely known and would depend upon many conditions. It is safe to assume that a large part of the nitrogen is lost, escaping as free nitrogen into the air. If the soil is kept under good cultivation, if the soil particles are not too coarse and if the amount of water present be regulated by drainage and cultivation, the quantity of nitrogen so lost will be much reduced.

To give the matter of the relative values of soy beans and cowpeas in building up an exhausted soil, a plot 16 rods long 7 rods wide, which had borne sugar beets for seven consecutive years was divided into three equal parts, each 4 by 7 rods in area. On one of these plots soy beans were sown in 1903, on the next cowpeas and on the third buckwheat. In the fall it was found that the roots of the cowpeas were fairly heavily loaded with nodules while the soy beans had few. The green crops were plowed under and the whole area sown to rye in the fall of 1903.

In the spring of 1904 a strip 4 rods wide across all three areas was plowed, one rod planted to white beans, the next to field peas, the third to cowpeas and fourth to soy beans, leaving the rye nominally 49.5 feet wide but really 45.25 feet. By this method soy beans followed soy beans, cowpeas, and buckwheat and it was possible to make a study of the influence of the previous crop on that legume. The same thing was true of the cowpeas.

The rye was cut July 15. Where following the soy beans the yield was 407 pounds; after the cowpeas it was 387 pounds and after the buckwheat 367 pounds, the areas being equal, and 4 rods by 45.25 feet. The yield of grain was 134 pounds, following the soys, 115 pounds, following the cowpeas, and 119 pounds following the buckwheat. Through the season it was noted that the rye was slightly taller after the cowpeas; it was also slightly later in ripening on this strip.

The white beans occupied a strip a rod wide with equal areas on the plots which had borne in 1903, the soy beans, cowpeas and buckwheat, the area on each 1 rod by 4. The yields of straw and grain were as follows:

	Straw.	Grain.
After the soy beans	42 lbs.	25 lbs.
After the cowpeas	32 "	24 "
After the buckwheat	32.5 "	25 "

The field peas also occupied a strip 1 rod wide across the 3 plots. The yields were:

	Straw.	Grain.
After soy beans	82.5 lbs.	27 lbs.
After cowpeas	78.5 "	30 "
After buckwheat	72.5 "	25 "

Of the cowpeas, also 1 rod wide, the weights, green alone, were taken. The yields were 90 pounds after the soy beans; 99 pounds after the cowpeas, and 91 pounds after the buckwheat.

The yield of the soy beans were 273 pounds after soy beans; 227 pounds after the cowpeas, and 231 pounds after the buckwheat.

The soy beans and cowpeas gave greater yields when grown the second year on the same area than when following each other. The rye had the highest yield after soy beans, as did the white beans and field peas if straw and grain are considered together. The field peas gave a greater yield of grain after the cowpeas. Before any definite conclusions can be drawn the experiment must be repeated.

ENSILOING SOY BEANS.

On the 15th of September, 1904, 13,590 pounds of soy beans, just harvested, were put into a silo.

Beginning in the last week of April, 1905, this silage was taken from the silo and fed to the cows. The silage had a peculiar and unpleasant odor which filled the whole dairy barn and was noticeable for many rods. The silage when weighed out amounted to 11,285 pounds and had the following composition:

Water	68.97%
Ash	5.69%
Ether extract	2.97%
Crude fiber	9.09%
Protein	3.28%
Carbohydrates	10.00%

In bulletin 103 of the Kansas Station, page 253, there is given the coefficients of digestion of soy beans when fed with kafir corn.

The Wisconsin Station reports unpleasant consequences in the flavor of the butter from the feeding of soy bean silage. When the silage was fed at this station a characteristic and unpleasant flavor was noted in the butter. The silage appeared to have kept in good condition. It was brown in color, not badly fermented nor soft but normal in texture and condition. The bad odor seems to be inherent in the silage itself and not due to abnormal fermentation.

There were 7,036 pounds of soy beans cut into the silo with an equal weight of corn. In this silage the same unpleasant odor was noted. Inasmuch as the soy beans do not grow tall and do not therefore stay bound in the bundle with the corn when cut with the harvester and inasmuch as repeated experiments at this station show that the vines of the Red Speckled and of the Southern Prolific beans cling to the corn and are harvested with it, it is suggested that one or the other of these legumes be used instead of soy beans for enriching in protein corn in the silo.

BULLETIN 228

JUNE, 1905

MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DEPARTMENT OF BACTERIOLOGY AND HYGIENE.

**THE DISCUSSION OF THE MILK PROBLEM FROM
THE STANDPOINT OF PRODUCTION.**

BY

CHARLES E. MARSHALL.

**AGRICULTURAL COLLEGE, MICHIGAN
1905.**

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of the Station

THE DISCUSSION OF THE MILK PROBLEM FROM THE STAND- POINT OF PRODUCTION.*

CHARLES E. MARSHALL.

The milk problem, as it pertains to the supplies of towns and cities, may be approached from two directions—the one as the consumer considers the question, and the other as the milk producer regards it. In our discussion of this problem, it is the purpose to approach it from the standpoint of the milk producer, because we believe this side seldom comes to light, and is less understood than that of the consumer. By doing this we hope to bring out some of the facts which will enable us to consider the whole milk problem more sanely and conservatively than is usually the custom without a knowledge of what the producer has to contend with. It is a pity that the city consumer, and usually the inspector, know so little concerning the cost of producing milk and those steps in manipulation necessary to the securing of a pure milk. Since this knowledge must furnish the appreciative spirit and rational interpretation, may we be permitted to view the situation in a concrete form and supply facts which are not usually considered by sanitarians?

If, as is sometimes recommended, a model stable is erected, such as is frequently taken as a type in sanitary contentions over the milk problem, we shall find that there must be something like \$15,000 or \$20,000 invested in buildings for a proper conduct of the dairy. It is not required that so much money be invested in stables to secure pure milk, but is the actual investment in some instances, and may be properly considered here. Pure milk may be obtained with moderate priced buildings, and we shall show later how greatly the expenses may be reduced by moderate capitalization.†

Those who rent real estate, hoping to get back what they invest at a fair rate of interest, do not feel that they can take less than 10 per cent of the investment in rent. When repairs, taxes, insurance and the ordinary depreciation in the value of property are taken into account, it must appeal to every investor that this is only a fair rate of interest on such investment. If this is true of a dwelling house, it is also fair to suppose that it would be true of a barn or stable investment. Ten per cent of \$20,000 is \$2,000. This stable should have a capacity for 100 milch cows. If these are fair cows, they will average at least \$75‡ each, or \$7,500 invested in cows alone. Animals are not so long-lived as a building, and are likely to cease giving returns at almost any time because of sickness and various other troubles which are peculiar to animals. It is doubtful whether 20 per cent would be too high a rate of

* This paper was read in part before the "Conference of Health Officers of the State," June 2, 1905.

† It should be borne in mind that the cost of milk is subject to wide variation because of the variable conditions and factors which control it. Our purpose is to put in definite form, so far as feasible, estimates which will represent fairly the usual cost of milk production, as gained from various sources and subjected to the criticism of competent practical men.

‡ Prof. Beach's figures are used as a basis. He places the value of the cow at about \$60.00. Everything taken into consideration, \$75.00 will not be found extremely high.

interest to place upon these animals. This amounts to \$1,500 per year. The total investment, therefore, ought to bring \$3,500 each year. Now what may be expected as an income, under the conditions named? Each cow of the type mentioned should produce at least 5,000 pounds of milk per year, or 2,500 quarts. If this is sold at the stable for three cents per quart, we have an income of \$7,500. Out of this must be taken the cost of labor and the cost of food. The cost of food will average about \$53* per head, or for 100 head of cattle, \$5,300. The cost of labor will average about \$25 per head, or \$2,500. It is true that there will be other small items of income, but, on the other hand, there will be other incidental expenses, which we shall allow to offset each other. Our total expenses, therefore, for the year, would be \$11,300. and our income \$7,500 per year, leaving a deficit of \$3,800 per year. In order to make this good, it is necessary to raise the price of milk at the stable from three cents per quart, upon which these calculations are made, to four and one-half cents. In order to retail milk, delivering to customers in the city, it is necessary to add 100 per cent. to the cost. In other words, milk should cost the consumer in the city, at least calculation, nine cents per quart. This assumes that all conditions are ideal, that there are no profits above expenses, and that there is no high priced manager conducting affairs, and further that everything is done in a very moderate way unless the *high priced barn be considered*. If everything were to be carried on in an ideal manner, it will be found that a price of twelve cents per quart is not too high for the quality of milk which is sometimes furnished. It is possible and perhaps desirable to reduce the investment in the stable to \$5,000; this would lessen the expense by \$1,500, which in turn could be applied upon income for a competent manager and profits from the business, keeping, therefore, the cost of milk about the same as already estimated. Under the dairy conditions which exist in Michigan, many cows do not furnish 3,000 pounds of milk per year, therefore, scarcely pay for their keeping. It is safe to estimate in the face of Beach's figures, \$53 per head or even at \$40 per head for feed, that there are more cows in Michigan not paying their cost of keeping than there are which do pay profit. In the advocacy of pure milk supplies, while we may have very high ideals, it is essential that we investigate conditions as they exist. Considering the milk producer's side, it is easily seen that a pure milk supply cannot be furnished every town or city at will, but must be a matter of growth and development. The dairies surrounding a town or city should be managed for profit as well as purity and also for future possibilities, since years are required to get together a profitable herd of dairy cows.

****Estimate of cost of production of pure milk, based upon:**

Time = 1 year.

Feed = \$53—\$40 per head.

Cow = 2,500 quarts milk.

Labor = \$25 per head.

As constant factors.

**Bulletin No. 166 (1899) Michigan Experiment Station—C. D. Smith.

Bulletin No. 29 (1904) Storrs Agric. Experiment Station—C. L. Beach.

Director C. D. Smith in Bulletin No. 166, 1899, of Mich. Station makes the cost of feed per cow \$35.96. At this time on account of higher prices for the various food-stuffs, \$40.00 per cow may be regarded as the lowest extreme. There should also be taken into account the relative costs of feeds for Connecticut and Michigan, the latter being more favorably located for securing lower prices

Investment:	Highest.	Lowest.
Buildings (stable, dairy, etc.)	\$20,000	\$5,000
Cows, 100 head	7,500	5,000
	\$27,500	\$10,000
Interest on Investment:		
Buildings at 10 per cent.	\$2,000	\$500
Cows at 20 per cent.	1,500	1,000
	\$3,500	\$1,500
Expenses:		
Interest	\$3,500	\$1,500
Manager	1,500	1,500
*Feed	5,300	4,000
Labor at \$25	2,500	2,500
	\$12,800	\$9,500
Income:		
250,000 qts. milk (2,500 per cow) at 3 cents per qt. at stable.		\$7,500
250,000 qts. milk, at 5 cents per qt. at stable.....		12,500
Permit other receipts and expenses to offset each other.		
Loss under highest estimate.....	=	\$300
Loss under lowest estimate.....	=	2,000
Gain of lowest estimate with high priced milk.....	=	3,000

Another phase of milk production in my judgment does not usually appeal to the sanitary commenter or milk consumer. If one were to make a close investigation with the idea of determining how many farmers are capable of producing milk *profitably* and *in a pure form*, I am certain it would be found that less than one per cent could fulfill the requirements. A man capable of producing milk that will answer the requirements of the sanitarian is an unusual agricultural man and one fit for success in almost any profession. He must be a thoroughly capable man, and, being a capable man, of course demands a fitting remuneration. His profession and himself are too little appreciated by society and scientific men. It is necessary that he know how to breed animals successfully and by so doing develop their capacity for milk production, at the same time keeping his animals sound. He must know how to feed animals economically and in such a manner as not to create any physiological disturbance, thus giving rise to an abnormal flavor or aroma in the milk, and still maintain the yield and richness of the milk. It is necessary that he not only have this as theoretical and scientific knowledge, but he must also be able to apply his notions in a practical manner, reaching every individual animal and every detailed operation under his care, for every animal has its idiosyncrasies, and these idiosyncrasies, to a large extent, determine profit or loss, and every operation must be adjusted to circumstances; in other words, he must be a man of great resources. He should recognize and diagnose immediately any disturbance in an animal or any factor which may cause bad milk or decrease its flow. The relationship between milk production and

physiological processes he knows in a practical way, better than a scientist knows from analysis, and can usually give more satisfactory answers. The producer of milk must be acquainted with milk and its handling, he must appreciate that the feeding of ragweed, chickweed, silage, turnips, and many other substances well known to him will give rise to an undesirable quality of milk, must also know that certain diseases alter the milk, that others are dangerous, and must understand that many physiological and emotional disturbances may change the character or nature of the milk. These things he has learned from science and experience, and one by one he has mastered them to the extent that he is able to meet at a moment's notice any of the usual emergencies which arise. This side of the production of milk is seldom brought forward, and people too little realize what it means to produce pure milk or what it costs. If the consumer in the city finds that his milkman is raising the price of milk one cent per quart, he immediately concludes that there is so much clear gain going to the producer, accordingly, when once the price and standards are established, it is very difficult to change. If a hardware merchant raises the price of some article as nails, that merchant at once conveys to his customer that it is due to an advance in steel. A few years ago bran could be secured for a few pennies per hundred, hay was cheap, and all the foods which are necessary for the feeding of cows had a low market value as compared with present prices. The cost of the food of one cow, which a few years ago would not amount to more than \$20 per year, at the present time, as has been stated, has gone to \$53. The price of milk, however, has undergone little change. It would seem, therefore, to arrive at a satisfactory conclusion in the matter of pure milk production, all controlling factors and circumstances should be carefully weighed by inspectors and consumers, what it costs to produce milk, the ability required in the milk producer, as well as stringent regulations in handling.

Competition is no mean influencing agent. It is a well known fact that in our smaller places, reliable farmers have attempted to produce a good quality of milk for their customers and to sell it at a fair price. Their charges estimated from cost of production, have been very reasonable, say six cents per quart. After starting, some irresponsible man would undertake to sell milk at three, four, or five cents per quart; consequently the good milk was soon crowded out and there was left upon the market only this poor quality of milk. This irresponsible man could then raise the price of his milk.

Another feature which is very important may be considered. It is safe to estimate that at least ninety per cent. or even more of the people of any town or city are unwilling to pay extra prices to secure a product which is guaranteed to be clean and free from disease germs. They simply demand cheap milk and they usually get it.

It may be excusable to introduce at this point some directive words concerning the handling of milk. Milk, as it comes from the udder of a cow, is not absolutely free from germs, the number ranging anywhere from 0 to 3,000 per cubic centimeter. These bacteria present when milk is drawn from the animal are not seriously detrimental to the product if properly handled unless some disease producing germs are in it; but if improperly handled, trouble may arise even if the milk is as pure as a milk producer can secure it. Proper handling of milk applies

equally as forcefully to pure milk supplies as to contaminated milk supplies. For instance, it is nearly as essential to keep pure milk cold as it is to keep foul milk cold, but this may be said: Where pure milk is produced there is little trouble with methods of handling, for whoever will produce pure milk will handle it properly. Most of the contaminations to which milk is prone will be found during the milking process and in the manipulation before cooling or bottling. Contaminations are in the form of the dirt from the animal, from the stall, from the bedding, feed and floor, from the utensils, and from the milker. In order to successfully eliminate these various forms of filth, it is necessary that the manager understand bacteriological principles as well as the surgeon. The problem the producer has to contend with is fully as complex as that which the surgeon meets; the surgeon has his complications, so also the milk producer; the surgeon has his fee of one or two hundred dollars for a single operation, but the milk producer has his meager gains and condemnation if every thing does not result satisfactorily. I bring this to the front not to complain of the intelligently directed skill of the surgeon and his very modest fees, but to illustrate a serious state of affairs in milk production. A surgeon is protected by law, but every ignorant man thinks he can produce milk, and sell it for less than it really costs. The dairyman must sterilize his utensils, must eliminate the dust of the stable, must guard himself to insure cleanliness; the cows must be thoroughly groomed and cleaned; in fact, if you compare one operation with the other, there will be found many points of similarity existing between the milk manipulator and surgeon. You say a surgeon should be a pathologist, a physician, etc.; this granted, the dairyman must be an agriculturist, breeder, etc.—they balance up very evenly. If this is true, can an untrained and inexperienced farmer produce a good milk? Are we not asking too much? It is the same old story with sanitarians as with all mankind—we preach what we do not know, we expect ideal conditions where only fair are possible, we advocate the things of the millennium when we are just emerging from barbarity.

It would be advantageous to have a stable which can be kept clean, stalls which would contribute no dirt, cows which were so thoroughly cleaned and clipped that no dust or dirt would fall from them, a milker dressed in a duck suit and sterile, a milk pail that is free from any contaminating material, and proper apparatus for aerating, cooling, and bottling milk—I repeat that it would be advantageous; it is practical, but only to the man who can carry these things to execution. Only one man out of every hundred milk producers is capable of doing it, in my judgment. It would also be desirable if there could be a separate milking room with all the conveniences, the water supply, cooler, aerator and other utensils, and the foul odors of the stable completely eliminated, but all of these conveniences must accord with the cost of production. If the consumer is willing to pay ten or twelve cents per quart for his milk, then the milkman or the milk producer should be compelled to produce that quality of milk; but if, on the other hand, the consumer is willing to pay only five or six cents per quart, then the consumer must expect to have that quality of milk furnished to him. At five cents per yard you cannot buy silk or broadcloth, but you can buy certain kinds of cotton. If we are to fight for a pure milk supply,

let it be a fight for something that is definite and to the point; something that we know can be produced; it must be something that we know can be produced at a profit to the producer. Let the matter be put on a business basis. If we demand an eight cent milk and know exactly what eight cent milk means and can specify by contract, the producer who is willing to so contract should carry out the terms of his contract or go to the wall. It follows from what has been said that in order to place our milk supplies upon a more favorable basis, it will be necessary to establish specifications and then endeavor to find such men who are willing to furnish milk according to specification. Let the five cent man furnish five cent milk, the eight cent man, eight cent milk, and the ten cent man, ten cent milk, and let it be the business of the inspector to not only see that these specifications are fulfilled, but let him see also that the consumer knows the difference between five cent milk and ten cent milk. This will be an attempt in the right direction, will be an open deal between producer and consumer, and will be fair to all parties concerned. Under such specifications it will be necessary that an inspector know his business. He will be neither all producer nor all consumer; neither medical man nor veterinarian; neither bacteriologist nor chemist, but he will be a man trained for a special purpose, trained in all scientific and practical subjects, so far as they pertain to milk production and consumption, and if trained properly, will be able to adjust all differences satisfactorily. To my mind, there is no necessity for arbitrary compulsion; no necessity for city authorities antagonizing milk men; nor, on the other hand, should it be necessary for milk producers to defend themselves and resort to dishonest methods unbecoming men. Let the fight for pure milk be an open, business deal between man and man. The necessity for pure milk exists. Few realize it more than the writer. The author is heart and hand in the movement, but unless this can be accomplished in a manner that is just to all men, then it will be as well to let it drop until it can be dealt with frankly. In personal encounters with milk producers, the writer has found that there are hundreds of ways by which they can outdo the milk inspector or overcome any compulsory enactment; in personal encounters with milk inspectors, ninety-five per cent. or more of them neither know what milk production is, what constitutes the proper handling of milk, or the significance of consumption of bad milk. They have learned mechanically to test for fat by the Babcock method, have learned how to stick the lactometer into milk, perhaps can make a plate for counting germs, but that is all. Scarcely one of them can give the significance of a single test. What good does it do? It keeps the milk man angry and they constantly devise ways of circumventing the regulations. Cooperation which is mutual will yield the best fruits. Most men know when they have fair treatment. As it stands at present, the farmer thinks he knows his business better than the inspector and the inspector thinks he knows his business better than the farmer, when both are densely ignorant of their own and the business of each other. The chasm between is immense and needs bridging.

It may be pertinent to enumerate many of the subjects to be treated in the production of pure milk. Each item needs further explanation and discussion when carried into practice, otherwise interpretation would be difficult under varying conditions and circumstances. In

carrying such a scheme into execution, it will also be necessary to select such items as may seem fair in the production of five cent milk, such as may seem fair in the production of six cent milk, and so on with the production of each grade of milk until *all* are embodied in the best grade.

The milk producer should therefore agree, depending upon what grade of milk he wishes to produce:

1. To provide and compensate a competent man to conduct the tuberculin test.

2. To apply the tuberculin test whenever ordered by the inspector or whenever in his judgment it is thought desirable.

3. To place in the hands of the inspector a copy of the records of temperatures and reactions.

4. To isolate any animal responding to the tuberculin test.

5. To pay any expense incurred by the test, breakage of thermometers, et cetera, which may not be herein mentioned, other than the duties and offices contributed by the milk inspector himself.

6. To sell no milk from any cow which reacts to the tuberculin test.

7. To remove any cow from the sound herd which in the judgment of the milk inspector may be regarded as unsound in any respect.

8. To sell no milk from any cow which may be pronounced unsound.

9. To furnish no milk to any one within the boundaries of town or city if any contagious disease is established in the family of the milk producer, unless circumstances will warrant permission from the milk inspector.

10. To keep the stable clean in the opinion of the milk inspector.

11. To properly ventilate the stable and dairy room.

12. To properly drain the stable.

13. To bed with clean straw or anything equally acceptable to milk inspector.

14. To provide pure water for the cows.

15. To provide sufficient and suitable food for the cows and nothing which will injure the milk.

16. To groom the cows thoroughly.

17. To have sufficient room about the cows or sufficiently large stalls.

18. To give the cows sufficient exercise.

19. To clip the hair from udder as often as it may be necessary.

20. To sponge the udder off with tepid water and take up any surplus moisture before milking.

21. To insist that each milker wash his hands carefully before milking.

22. To wear clean and sterile clothes while milking.

23. To provide a milking room, if required.

24. To have all pails, cans, and utensils perfectly cleaned with warm water, sal soda, lime water, and boiling water as directed by milk inspector.

25. If milking is done in stable, to remove immediately after milking each cow's milk to aerator and cooler.

26. To cool the milk down at once to 40 degrees Fahrenheit, or below by passing over cooler.

27. To maintain milk in cans at temperature of 40 degrees Fahrenheit, or below until delivered.

28. To use milk pails, milk cans and other milk utensils for milk only.
29. To provide 40 pounds of ice for every 100 pounds of milk produced.
30. To use no milk from a calving cow till twelve days after calving.
31. To use no preservatives, diluents, or adulterants in the milk.
32. To maintain a specific gravity of at least 1.029 in milk.
33. To maintain at least 3.5 per cent. butter fat in milk.
34. To maintain at least 12½ per cent. total solid.
35. To maintain a bacteriological cleanliness satisfactory to inspector.
36. To furnish a list of patrons to the milk inspector and correct it weekly.
37. To contract with the milk inspector, who will represent the municipality, to produce a certain quality of milk specified in agreement.
38. To carry out any suggestions of the milk inspector that are considered necessary for the health of those consuming the milk and for the good of the milk.
39. To keep the milk inspector informed of any irregularities in the herd or dairy.
40. To unite with the milk inspector in seeking improvement so far as it is feasible.
41. To sell no milk other than that coming from the milk producer's cows without the consent and approval of the milk inspector.

The contracts should embody in them detailed and full specifications as to:

I. Stables.

- a Location.
- b Drainage.
- c Structure.
- d Ventilation.
- e Lighting.
- f Space.
- g Stalls.
- h Milking room.
- i Cleanliness.
- j Water Supply.

II. Cows.

- a Soundness.
- b Condition.
- c Number and kind.
- d Grooming.
- e Clipping of udder.
- f Exercise.

III. Feed.

- a Kind.
- b Quantity per cow.
- c When fed to cows.

IV. Milker.

- a Health.
- b Neatness.
- c Clothes.
- d Hands.
- e Method of Milking.

V. Dairy.

- a Location.
- b Drainage.
- c Structure.
- d Lighting.
- e Ventilation.
- f Plumbing.
- g Cleanliness.
- h Space.
- i Equipment.
- j Water Supply.
- k Ice supply per 100 lbs. milk produced.

VI. Utensils.

- | | | |
|-------------------|-----------|--------------|
| a Milk pail. | } as to { | Kind. |
| b Cooler. | | Cleanliness. |
| c Other Utensils. | | Management. |

VII. Management of Milk.

- a How milked.
- b Where milked.
- c When cooled.
- d How cooled.
- e How sold.
- f How delivered.
- g Temperature of milk at time of delivery.

Laboratory of Bacteriology and Hygiene, June 10, 1905.

BULLETIN 229**JUNE, 1905**

MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DEPARTMENT OF BACTERIOLOGY AND HYGIENE.

A POPULAR REVIEW OF SPECIAL BULLETIN NO.
33 ON "THE ASSOCIATIVE ACTION OF BAC-
TERIA IN THE SOURING OF MILK."

BY

CHARLES E. MARSHALL

AGRICULTURAL COLLEGE MICHIGAN

1905

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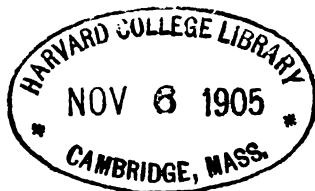
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SUB-STATIONS.

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
Chatham, Alger County, 160 acres deeded.



A POPULAR REVIEW OF SPECIAL BULLETIN NO. 33 ON "THE
ASSOCIATIVE ACTION OF BACTERIA IN THE
SOURING OF MILK."

CHARLES E. MARSHALL.

For the last two years the attention of the writer has been directed to the determination of the favorable influence which certain micro-organisms, usually producing no acid, frequently digesting milk, and many times curdling milk, exert upon the growth of lactic bacteria (those germs commonly souring milk) accordingly hastening this process. It is understood that these lactic bacteria in milk cause the changing of the sugar of milk into an acid, called lactic acid, and this in turn acts upon the casein, of the milk or the cheese content of the milk, producing a lopper. The bacteria which exert a favoring influence through a partial digestion of the milk, find their way into the milk through the filth of the stable, as, hairs of the cow, dirt from the cow, dirt from the floor of the stable, dirt from the feed, dirt from the milking utensils, in fact, they reach the milk through any avenue which is likely to be contaminated in any degree with dirt of one nature or another. It follows, therefore, that there is present in the milk a mass of bacteria consisting of many kinds,—those which are capable of souring milk directly; those which are capable of growing in milk and digesting it, leaving only a watery fluid behind; those which are capable of curdling the casein or cheese product under sweet or sour conditions; and many other kinds which are able to produce various alterations. Our associative studies in this instance are confined to the lactic bacteria and a few of those which usually digest milk without an appreciable formation of any acid.

It has been suspected for some time that the lactic type of bacteria does not always account for at least occasional peculiarities noticed in connection with the souring of milk. With the knowledge that this souring is produced by a definite lactic micro-organism in most instances, its isolation and its cultivation in sterile milk ought to yield the same results as one would succeed in getting in the souring of milk under dairy environments. This, however, is not always true. Through the discovery of these influencing micro-organisms upon the lactic germs, it is possible in part to explain many of the variations which occur in the production of sour milk by lactic bacteria.

While the associative studies in connection with the souring of milk are more or less in an inceptive stage, they are along the same line as several other fermentations which have already been familiar for many years.

The nature of vinegar fermentation, with which we are all somewhat acquainted, is something that will appeal to every layman not fully in touch with the technique of micro-biology. It is a matter of common knowledge that in the production of vinegar, alcohol is first manufactured by a yeast plant from the sugar of the fruit. Following the production of alcohol, bacteria develop which convert the alcohol produced by the yeast into an acid, called acetic acid, which yields the vinegar of commerce. This association is required to yield the proper fermentative results. The yeasts are practically necessary for the cultivation of the bacteria and the bacteria are essential in the production of acetic acid for vinegar. In several fermentations, associative life exists, as is met in kephir and koumiss, ginger beer, and others. Again, in disease mixed infection frequently occurs. This mixed infection many times hastens the development of the disease and perhaps there are cases where it acts as a hindrance. Diphtheria in its pure form is caused by a rod-shaped micro-organism and pursues a definite course, but when mixed with a certain spherical micro-organism, an aggravated form of the disease may follow. In the soil are instances of associative growth: for instance, it has been demonstrated that there is a distinct germ which is capable of liberating free nitrogen from combined nitrogen, but that this liberation does not take place through the agency of this germ very freely unless there is associated with it another micro-organism which is known as the colon germ.

These examples will be sufficient to meagerly illustrate the possibilities of association in a world of micro-organisms. Farmers have doubtless recognized that certain plants grow only in the presence of other plants,—again illustrating in the higher world the effect of associative development. This may doubtless be extended into the animal kingdom, and perhaps could be carried into regions which we know nothing about at the present time.

By the studies conducted in this laboratory, it has been possible to demonstrate that when the lactic bacteria are associated with certain other bacteria the lactic germs are capable of producing a greater amount of acid through this association than when grown alone without the influence of any other germs; that the milk in which the two germs are grown will lopper sometimes as many as 72 hours earlier than the milk in which the lactic germs are grown alone; that the number of lactic germs also increases much more rapidly when under the influence of association than when alone. Allow A to stand for the lactic bacteria, B to stand for the associated type, then the number of lactic germs developing in single and combined culture may be represented as follows:

$$A : A + B :: 27 : 1614$$

It is also interesting to note that if we should allow the germs designated by B to grow in milk for 48 hours, then kill them by sterilization, the milk in which they have grown will give the same results as when the living germs B are grown with the lactic germs. Products are formed by the growth of germs B in the milk which do not yield to sterilization; in other words, they are stable. These products have the same influence upon the lactic germs in influencing their growth, in hastening the formation of acid, and in reducing the number of hours

necessary for the lopping of the milk as the living germs B. We may conclude, therefore, that the products are probably the important influencing agents.

While it has been positively shown that certain micro-organisms may influence the lactic bacteria in the souring of milk by hastening the process, and also that these micro-organisms apparently exert their influence in the milk through the formation of distinct products which in turn are capable of accomplishing in the growth of lactic germs what the living germs have been demonstrated to accomplish, there are also other factors entering into the study of this associative action which must be carefully considered, otherwise erroneous conclusions are likely to creep in. Among these factors the most important to the mind of the writer is that of the possible variations in our cultures resulting apparently from the differences existing in milks. At first it was suspected that by the use of dairy milks these differences in milks could be explained by the formation of bacterial products through the rapid development of germs usually pervading dairy milks. Studies conducted to determine whether this would lead to the probable explanation resulted in finding some variation, for by taking samples of milk from the dairy at different times it was discovered that when tested the usual variation in acidity existed, but if subjected to heat the milk did not always respond the same even when the acidities, measured by phenol-phthalein, were identical. For instance, 20° sometimes lopped and sometimes did not upon heating; 21° sometimes lopped and sometimes did not upon heating; 22° sometimes lopped and sometimes did not upon heating. If acidity measures the time of lopping of milk, then we must conclude that the indicator is not at all reliable; if the acidity is not the cause, we must seek another explanation for the variation secured in this test. Going to the cows themselves and securing milk that was perfectly fresh, it was found that the acidities, measured by phenol-phthalein, were marked by great variations. To illustrate:

Red Polled	Pansy Belle	gave 9° acidity.
	Grade 31	gave 18° acidity.
Holstein	College Houtje	gave 5° acidity.
Swiss	College Becky	gave 13° acidity.
Holstein	College Belle	gave 14° acidity.
	Grade 11	gave 17° acidity.
	Grade 17	gave 18° acidity.

Here is found considerable variation in acidity and, when these same milks were employed for the cultivation of micro-organisms, it was also discovered that micro-organisms responded differently to these different lots of milk. Whether this response may be attributed to the acidity is not positively demonstrated, for we know from past knowledge that the constituents of milk vary widely; that is, the fat is subject to great variation as well as the casein of milk. There may be some relation existing between the acidity and the normal constituents of milk and instead of finding that the micro-organisms respond to the degree of acidity, it may rather be found that they respond to the amounts of different constituents present. Besides finding that the germs respond differently to milks from different cows, it was also found

that milks gave different results upon the addition of rennet; that is, the milks from different cows curdled upon the addition of identical amounts of rennet in different periods of time. We may conclude tentatively, therefore, from our studies of different milks, that the results secured from the cultivation of germs in these different milks are subject to as great variations as the results of chemical analysis. Bearing this in mind, in order to secure satisfactory results in a study of associations of germs in milk, it is necessary to restrict oneself to milk from the same source and treated in an identical manner. otherwise unreliable data will be obtained. It has been found necessary to introduce this brief survey of milk variation in order to satisfactorily interpret our studies in association.

When germ B, or the germ which we have employed in connection with the lactic bacteria, has grown in milk for different periods of time, certain definite changes are produced. Inasmuch as these changes give rise to the products which we have shown may influence the growth of lactic bacteria as much as living germs themselves, it is interesting to know what this breaking down or digesting of the milk may be. Studied from the chemical standpoint, we shall find that the casein or cheese substance of the milk is almost completely dissolved and in its place are simpler nitrogenous products, such as peptones, amido and ammonia compounds, as well as other products of more or less complete digestion. It is impossible, from our present data, to definitely point out which of these products favorably hastens the growth of lactic bacteria. It may not be a single one, but several combined. At any rate, the digestion is doubtless the means of furnishing such products as will hasten the growth of lactic bacteria. It must be understood, too, that the products resulting from these particular germs are not identical with the products of all germs of this class, for we find germs which apparently digest milk in much the same manner, but have apparently no influence whatever upon the growth of the lactic bacteria. This would indicate perhaps that instead of some of these main products of digestion, which are indicated in our discussion as being the cause of the facilitated growth, that a secondary product, which is not apparent at all in our analysis, is the real stimulant of the lactic bacteria.

We can further say that no acid is produced by germ B, which we have studied so thoroughly. Although when grown in milk, germ B will in time curd the milk upon heating, we have demonstrated that it is not due to the presence of any acid, but to other products which are found in the digested milk. Besides germ B producing a favorable action upon the lactic bacteria, we have met with several others which are also capable of doing the same thing, but varying in degree only. Out of ten which we have partly studied, six are capable of favorably influencing the lactic germs.

It is also interesting to note how much association may influence the butter products. Mr. Wright has conducted some experiments in which he has demonstrated that in order to cover up the disagreeable odor and taste produced by germ B it is necessary to employ 45 per cent of good starter in the ripening of cream. It is desirable, perhaps, to introduce at this point a summary of Mr. Wright's work.

Cream Lot.	Division of Lot.	Amount of B Added.	Amount of A Added.	Condition of Butter.
I.	1	5%	21½%	Very strong of B.
	2	5%	5 %	Very strong of B.
II.	1	...	5 %	Tainted.
	2	5%	5 %	Very strong of B.
III.	1	...	8 %	Very good.
	2	5%	8 %	Quite strong of B.
IV.	1	...	15 %	Very good.
	2	5%	15 %	B easily detected.
V.	1	...	20 %	Excellent.
	2	5%	20 %	B easily detected.
VI.	1	...	25 %	Strong; B easily detected.
	2	5%	25 %	B easily detected.
VII.	1	...	30 %	Excellent.
	2	5%	30 %	B easily detected.
VIII.	1	...	35 %	Excellent.
	2	5%	35 %	B easily detected.
IX.	1	...	40 %	Excellent.
	2	5%	40 %	B easily detected.
X.	1	...	40 %	Excellent.
	2	5%	40 %	B easily detected.
XI.	1	...	40 %	Excellent.
	2	5%	40 %	B easily detected.
XII.	1	...	45 %	Excellent.
	2	5%	45 %	B practically disappeared.

This association of germs studied may cast some light upon the peculiarities or irregularities of milk souring known to nearly everybody; it may be the means of giving a better basis for advocating purer milk for infant feeding and other purposes, since the products, at times perhaps toxic, are so stable; it has already given a more rational view of starters and their control, as well as of the extent of their possibilities; and it has made lactic fermentation one subject somewhat to other microbial factors which have not heretofore been recognized.

Laboratory of Bacteriology and Hygiene, June 15, 1905.

MICHIGAN

STATE AGRICULTURAL COLLEGE



EXPERIMENT STATION

DEPARTMENT OF BACTERIOLOGY AND HYGIENE

SOME BACTERIAL DISEASES OF PLANTS PREVA-
LENT IN MICHIGAN.

[Popular.]

BY

WALTER G. SACKETT

AGRICULTURAL COLLEGE, MICHIGAN
1905

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Chatham, Alger County, 160 acres deeded.



SOME BACTERIAL DISEASES OF PLANTS PREVALENT IN MICHIGAN.

- I. Pear Blight.
- II. Bacteriosis of Beans.
- III. Black Rot of Cabbage.
- IV. Wilt of the Cucumber, Muskmelon and Squash.
- V. Soft Rot of the Sugar Beet.
- VI. Blight of the Irish Potato, Tomato and Egg Plant.

WALTER G. SACKETT.

PEAR BLIGHT (FIRE BLIGHT).

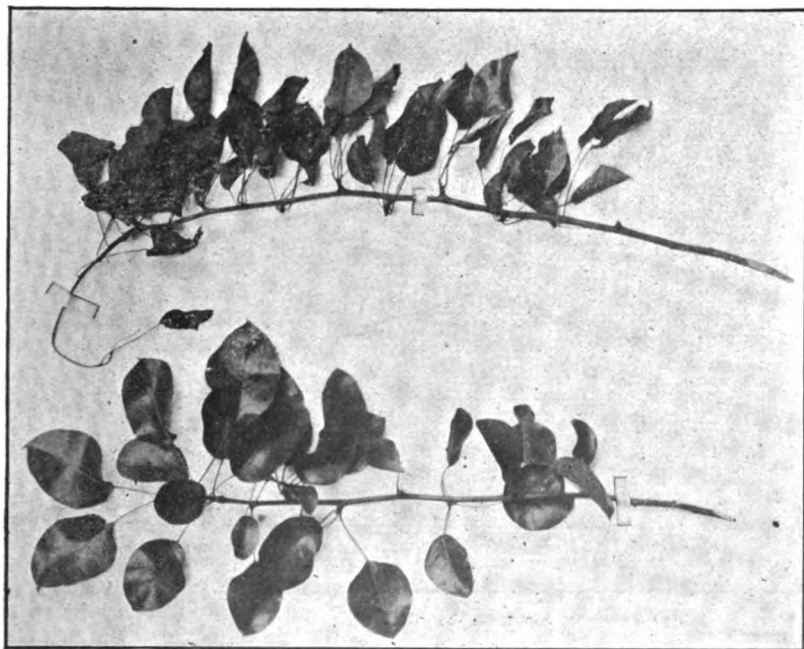


FIG. 1.—Two Pear Twigs; the upper one affected with Fire Blight, the lower one healthy.

Of all the diseases which affect the pear, there is none which is so universally dreaded by the fruit grower as the pear blight. This disease is by no means confined to the pear alone but also infests the apple, quince, crab, mountain ash, service berry and several species of hawthorne; hence the blight can spread from one kind of a tree to another.

The name *fire blight* is especially good because it is at once suggestive of the symptoms of the malady. To one not familiar with the disease, it can be recognized at first sight by the brown and subsequent blackened

appearance of the young leaf tufts and flower clusters; the young twigs show a blackened, shrivelled bark resembling very much green brush which has been only partially burned. The blight makes its appearance early in the spring shortly after the blossoms have fallen and working rapidly back from the blossom clusters, an inch or more a day, soon involves the tender succulent twigs and ultimately the whole limb. If the diseased wood be cut off with a sharp knife, a dark ring between the bark and the wood will usually be seen. This is a further indication that your tree is affected. As the disease progresses and the smaller limbs show the infection, the bark cracks and a thick, black, sticky gum exudes; soon afterwards the bark becomes dark colored, hardened and shrunken. When the leaves fall in the autumn, the diseased parts of the tree are left very conspicuous by the dead leaves hanging to the twigs. If the blight attacks the larger branches and trunk where there

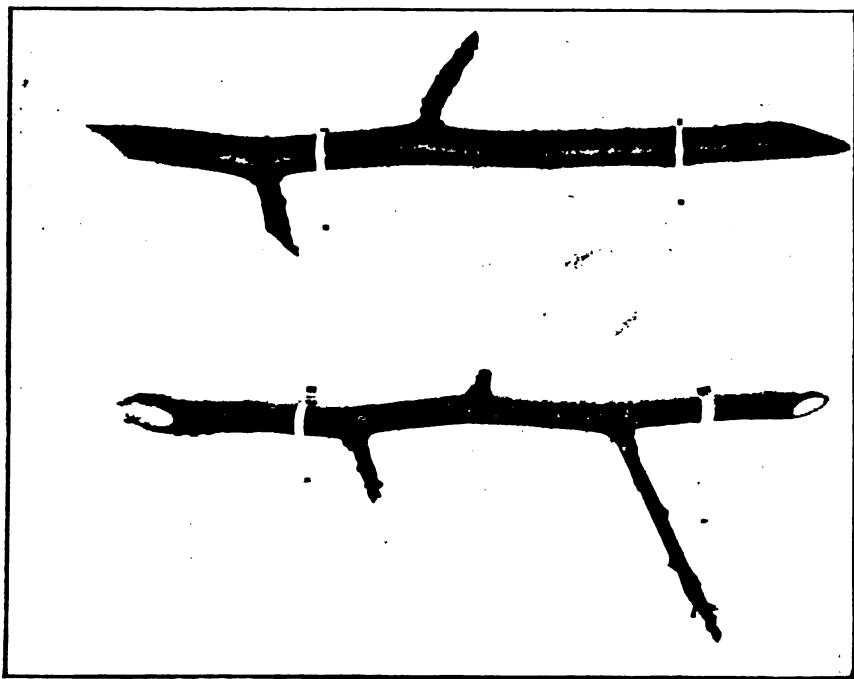


FIG. 2.—Pear Twigs. The upper one shows the smooth bark of a healthy twig. In the lower one note the dried up, shrivelled appearance caused by the Blight.

has been some mechanical injury or bruise, the symptoms are much the same as what is known as sun burn or sun scald. This form of the blight is known as rough bark or body blight.

In some of the most susceptible varieties, it is not uncommon to see the whole tree blighted in a phenomenally short time, sometimes within ten days. Occasionally it assumes its most severe form just previous to the picking of the crop. The writer has one pear orchard in mind numbering some four hundred trees which showed but three or four badly infected ones up to the middle of August, 1904, but within three

weeks after that, every tree in the orchard was suffering from a severe attack. The fruit had to be picked two weeks before time in order to prevent all from being ruined by the blight.

HISTORY.

The disease is by no means recent for it dates back to the time of William Denning who first reported the trouble from the Highlands of the Hudson in 1770. He described it fairly well and ascribed the cause to a borer in the trunk of the tree.

The oldest book on American Fruit Culture published in 1817 by William Coxe gives a very accurate description of the disease. From this early date up to comparatively recent times horticultural literature has been crowded with numerous extravagant theories of the cause of the blight. Even today we occasionally find men who hold to one or another of the old ideas. It may be interesting to know what some of these were:

1. Insects.*
2. Rays of the sun passing through vapors.
3. Poor soil.
4. Violent changes in the temperature of the air or the moisture of the soil.
5. Sudden change from sod to high tillage resulting in surplus of sap.
6. Effect of age.
7. Autumn freezing of unripe wood, which makes a poison destroying the shoots and branches the following spring.
8. Electricity in the atmosphere.
9. Freezing of the sap or freezing of the bark.
10. Fermentation of sap.
11. Absence of certain mineral matters in the soil.
12. Something in the air which is carried from place to place.
13. Fungi.

ORIGIN AND SPREAD.

In 1878, Prof. W. T. Burrell of the University of Illinois, succeeded in finding a kind of bacteria which he believed to be responsible for the disease.

The blackened twigs and sticky exudate were found to be alive with germs which are very small plants, so small, in fact, as to be seen only with a very powerful magnifying glass such as we find in the compound microscope. Some idea of the size can be gotten when you know that it would require 25,000 germs placed end to end to make one inch.

By taking some of this gummy material which contains the bacteria and inserting it into a healthy twig through a small cut, it was demonstrated that the inoculated twig took the disease and that therefore it could be spread from one tree to another or was what we call an infectious disease. It was also shown that this same gummy material from the pear could produce the disease on the quince and the apple. This experiment is very simple and can be tried by anyone who is interested in the infectious nature of the blight. It was argued by some that it was not the germs which produced the blight but rather the gum which was injected. To meet this objection, the germs were grown in a suitable medium such as beef broth and a quantity of the pure organ-

isms were inoculated into a healthy twig. The results were very conclusive for the twig soon died showing that the germs by themselves had the power of killing the plant.

The question which we now have to answer is, where does the blight originate when our orchards have never had it before? Where does it come from? It has been shown quite conclusively that it is not carried on the wind, neither is it traceable to the soil. Insects and especially bees have been seen feeding on the gummy material which runs out from the cracks in the diseased wood and knowing that this exudate contains millions of germs, it is only reasonable to believe that these insects carry the disease on their feet and bodies to the healthy trees. Alighting on a delicate flower cluster, they crawl deep down after the so called honey or nectar in the blossom and here many of the blight germs are brushed off and left in contact with the tender blossom. Through these honey ducts or nectaries the bacteria gain entrance to the plant. Once favorably situated, they multiply very rapidly and move down the twig between the bark and woody cylinder through the growing layer, known as the cambium layer, which is familiar to everyone as the region from which the annual rings arise. It is in this way that a large percentage of the cases originate. Again the germs may gain entrance into the tender shoots through insect bites in the bark for although the opening may be no larger than a pin prick, myriads of bacteria can find a temporary dwelling place in this wound and may soon spread through the whole member. Lastly, the infection may enter the large limbs and trunk of the tree by some scratch or bruise in the protecting bark which has exposed the susceptible growing layer beneath to the visits of germ laden insects.

Thus we see that pear blight is caused by a germ to which the name *Bacillus amylovorus* (Burril) has been given, the meaning of which is starch destroying. We see that it is spread from one tree to another by insects, especially bees, and that the germs may gain entrance into the plant in any of three ways: First, and most important, through the blossom; second, through insect bites in the tender shoots; third, through mechanical injuries to the bark of the limbs and trunks of the trees.

CONDITIONS FAVORING THE DISEASE.

Although the knife is our only hope of exterminating the blight, there are undoubtedly conditions which favor the disease.

It is a matter of common observation that climatic conditions have a marked influence; warm, moist weather with a large amount of rainfall favors it, while bright, dry, cool weather tends to check it. That is, the former conditions are advantageous to the growth of the germs while the latter are unfavorable.

High cultivation, rich soil, heavy manuring, the use of large quantities of commercial fertilizer containing a great deal of nitrogenous material and heavy pruning all tend toward the growth of tender, succulent shoots. It is in this sort of plant tissue, gorged with sap, that the blight germs can grow and multiply most rapidly. Biting insects whose mouth parts are contaminated with the casual microbes, are most partial to these juicy shoots and leaves and their bites often serve to infect the tree.

It is evident, then, that vigorous, healthy, rapidly growing, too well cared for orchards are more liable to the disease than others and since these are factors which the grower can control, it is he who must strike the happy medium which will not permit the trees to suffer and yet will not give ideal conditions for the development of the germs.

PREVENTION AND TREATMENT.

The treatment of fire blight is of two kinds—the one, preventative, which aims at making the tree resistant to the attacks of the disease; the other, curative, which is intended to exterminate the harmful microbes and thus prevent their spread.

(1) It is obvious that if we are to render our trees resistant to blight, we must avoid those conditions which increase the predisposition to the disease. We have already mentioned the most potent factors in the propagation of blight as high cultivation, rich manures, commercial fertilizer high in nitrogenous material, excessive soil moisture and high pruning. In short, anything which favors the rapid growth of tender, succulent shoots should not be practiced. It is understood, of course, that these suggestions are not to be followed without reason or the trees will suffer from troubles other than the blight. The trees should be allowed to ripen their wood and to this end the grower must use some means which will limit the moisture in the soil. It is recommended that some good cover crop such as oats be used for this purpose.

(2) With a disease working as this does in the juicy part of the stem between the bark and the wood, there is no chance of reaching the trouble by means of sprays for unless the chemicals come in contact with the bacteria, spraying is futile.

The knife and saw remain as the only effective remedies. We must cut out and burn all affected twigs, leaves and branches not only from the pear but the apple, quince and related species as well, so that there will be no infectious material near by for bees to carry into the blight free orchard. It is very essential in cutting out the diseased branches to cut well below the discolored part as the bacteria are usually far below this region, the discoloration not appearing until after the bacteria have been at work some time, so that even if all the blackened wood were removed the seat of the trouble would not have been reached, and the germs would live on in the apparently healthy stump, soon to cause another visible outbreak of the blight. The affected branches should be cut back all the way from ten to fifteen inches below the discolored wood and if the branch be a large one, more than one-half inch in diameter, the cut surface should be protected from wound rots by painting. Either lead and oil paint or shellac wash* or grafting wax may be used for this but the lead and oil paint is cheaper and less liable to crack than the others when exposed to the sun. The question may be asked, "When is the proper time to do the cutting?" The writer would answer, "Whenever the blight appears." Trimming out the diseased parts may be done at any time in the late fall, winter and spring. The most favorable time, however, is in the autumn after the leaves have fallen for then the blighted twigs become very conspicuous by the dead leaves still hanging to them. It is not advisable to postpone the cutting until

* The Connecticut Exp. Sta. recommends oil shellac to which is added a little flowers of sulphur and a few drops of carbolic acid.

the growing season, for at that time there is great danger of overlooking new cases which are constantly occurring owing to the lack of development so early in the season. If the entire tree is affected, there is little hope of saving it and the best procedure is to grub it out and burn the whole tree. Too much stress cannot be laid upon the complete destruction of the diseased wood for our only hope of stamping out the blight lies in removing the source of the infection. A single twig left on the ground unburned may mean the loss of the whole orchard.

The knife and the saw used must be sterilized after each cut in order that the disease germs clinging to the instruments may not be carried to the healthy parts of the tree. This can be done by passing the knife several times through a flame or it may be dipped into a 5 per cent solution of carbolic acid.

A careful inspection of the orchard should be made in the winter and spring before the blossom season in order to destroy any new cases that may have developed since the previous examination.

The greater part of the blight will be eradicated by one careful winter and spring cutting and if this be done and done thoroughly, the disease can be entirely controlled.

SUSCEPTIBILITY OF DIFFERENT VARIETIES.

So far as we know at the present time there are no varieties that are entirely immune to the disease. Several have been reported by growers as showing a greater power of resistance than others, among which may be mentioned the Duchess, Kiefer, Seckel, Anjou and Anjouleme. The more susceptible varieties are the Flemish Beauty, Clapp's Favorite and Bartlett.

Among the apples, the crabs in every case seem to take the disease most readily, but even here there are some which are freer from blight than others. It has been observed that the same variety in different localities and under different climatic conditions will exhibit different degrees of resistance. The Colorado Experiment Station* cites one case in a certain locality where Martha and Whitney crabs were grown alternately. The Whitney trees were either all dead or dying while not one of the Marthas was affected. However, in other localities the Marthas had succumbed to the blight.

In selecting trees, be guarded by local experience and choose the varieties which have done best in your locality.

*Bulletin 41 Colorado Experiment Station.

BACTERIOSIS OF BEANS.

Frequently the foliage, stems and pods of the common beans as well as the Lima bean are preyed upon by a bacterial disease* known as Bacteriosis. The symptoms are such as to make it readily distinguishable from all other maladies to which the bean is heir.

There appear on the different parts of the plant, especially on the leaves, large, watery, brown patches or blisters that soon dry up and cause the tissue to become brittle and to curl leaving the foliage ragged

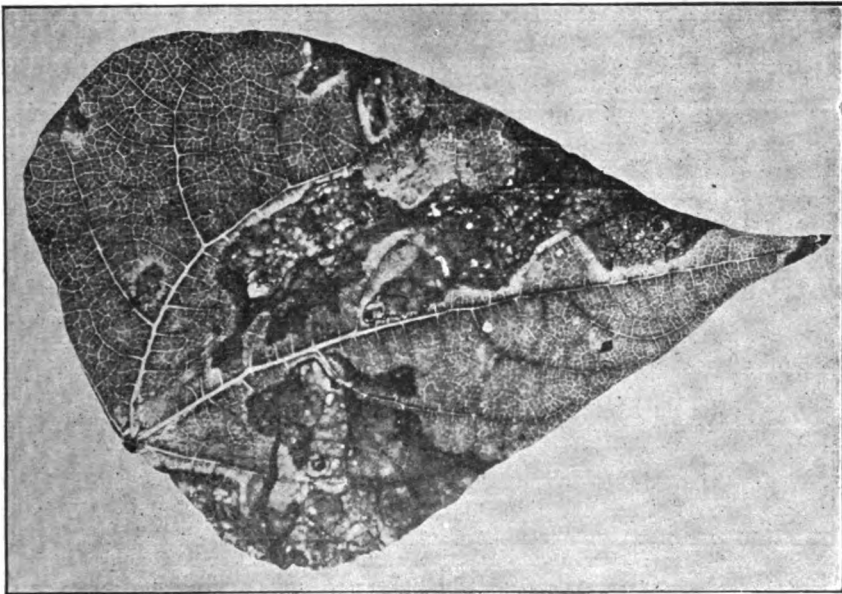


FIG. 3.—Bean Leaflet, showing Bacteriosis. (Halsted. New Jersey Station Bulletin No. 151.)

and good for nothing. The pods seem to furnish the best food supply for the microbes and it is here that we find the disease at its best. Small discolored spots appear at first which spread very rapidly and produce large lesions with pink or reddish brown borders and having pale yellow or amber colored crusts over the affected areas. This crust is due to the accumulation of myriads of amber colored bacteria which have formed a layer over the broken down tissue. After a time the pod rots and the beans are worthless.

Warm, wet weather seems to favor the disease for the germs grow best under these conditions and the beans at the same time produce more succulent growths which are more readily attacked. Rain and dew are doubtless agents in spreading the germs from one part of the

* *Pseudomonas phaseoli* (Smith).

plant to another by washing them from old lesions onto unaffected parts. Insects play an important part in disseminating the trouble, consequently any measures which tend to check these pests will aid in controlling bacteriosis. The distribution of the disease is further effected by dead vines and leaves carried on the wind; by the soil and through the seed. New land which has never grown beans seems to be freer from the disease than old and should always be used when available.

The seed used in planting should be selected by hand and all the lighter ones discarded, for Gain* reports that anthracnosed seeds are less dense than sound ones. As yet no satisfactory method has been found which can be recommended for treating the seed to destroy the casual microbe which does not lower the viability of the seed.

Inasmuch as the germs of bacteriosis work on the outside of the plant,

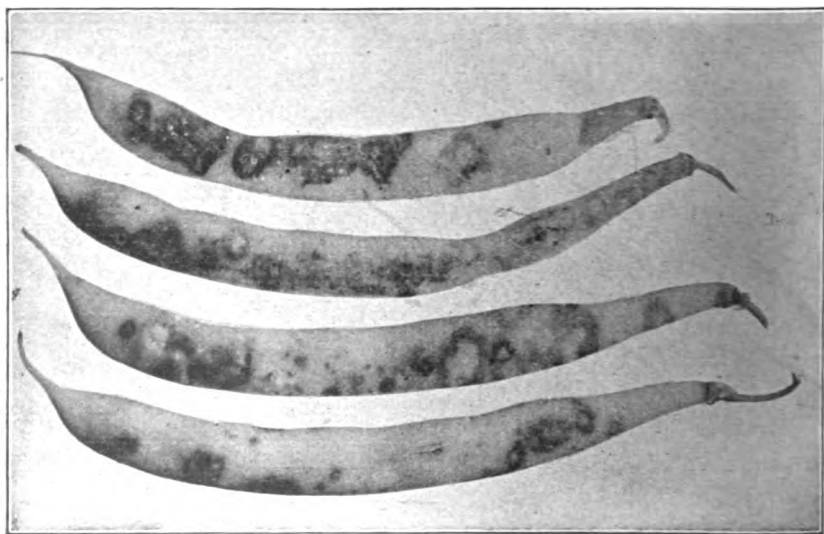


FIG. 4.—Four Bean Pods with Bacteriosis. (Halsted. New Jersey Station Bulletin No. 151.)

it is possible to reach them with a fungicide and spraying with Bordeaux mixture* upon two and three inch plants followed by the same ten days later and again after blossoming.† Dr. Halstead uses a Bordeaux mixture of the following strength: Copper sulphate, 6 lbs.; lime, 4 lbs.; water, 60 gals.

Variety tests conducted by the New Jersey Experiment Station during the three years 1897-1899 with Green Flageolet, Currie's Rust-proof, Early Mohawk, Golden Wax, Extra Early Refugee and Saddleback Wax showed the Green Flageolet, the most susceptible, and the Early Refugee the least.

*. Bulletin 151 N. J. Exp. Sta.

† Bulletin 121 Ohio Exp. Sta.

BLACK ROT OF CABBAGE.

The black rot of cabbage is to the truck producer what pear blight is to the fruit grower; in fact, it may be considered far worse, for on the one hand there is only the loss of the crop while on the other not only is the cabbage destroyed but in addition the soil on which it has been grown is so inoculated that it is practically useless to attempt to raise the same crop on the same field with any degree of success for a number of years.

Bacterial examination of diseased plants has shown the sickness to be due to a kind of germ.* The disease is by no means confined to the cabbage but attacks other cruciferous plants such as cauliflower, collards, kohl rabbi, kale, brussels sprouts and broccoli. It has also been

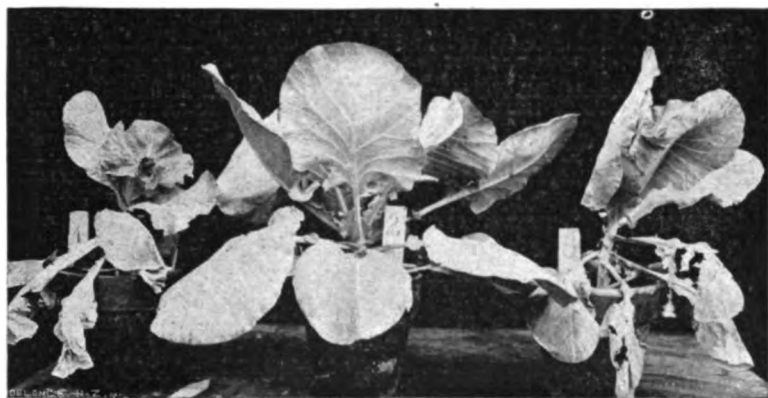


FIG. 5.—Cabbages showing effect of artificial inoculation. Middle plant vigorous and healthy (uninoculated). Plants 1 and 3 inoculated with Black Rot germs. Note dwarfed, one sided manner of growth. Russell. (Wisconsin Station Bulletin No. 65.)

reported as occurring in turnips, rutabagas, wild radish and mustard. It is widely distributed in the United States, having been found most prevalent east of the Mississippi River. In 1891 Prof. W. Paddock reported it from Colorado. Previous to 1899 we do not hear of the black rot in Europe but the investigations of Harding,† confirmed by foreign workers, show the disease to be wide spread and of long standing. England, Holland, Denmark, Austria and Switzerland are mentioned as constant sufferers from the malady. This is peculiarly interesting, since a few years back a great deal of our cabbage seed was imported from Holland and Denmark. The comparatively recent discovery of the infection in Europe is probably due to the better methods of diagnosing the disease than formerly rather than to recent appearance of the trouble. Cabbage growers of Europe have observed it for many years, it seems, but they were accustomed to associate the cabbage worm with the rot rather than the true bacterial cause.

* *Pseudomonas campestris* (Pannuel) Smith.

† Cent F. Bakt. II. Ab. Bd. VI.—305-313, (1900).

The disease can be recognized by the dwarfed, one-sided growth of the plants and in some cases, failure to produce heads. Sometimes the head will rot and fall off but this is not a necessary accompaniment of the disease for this symptom together with the bad smelling head may be due to the work of other bacteria which are living on the tissue already weakened by the true black rot organism. In the early stage of the

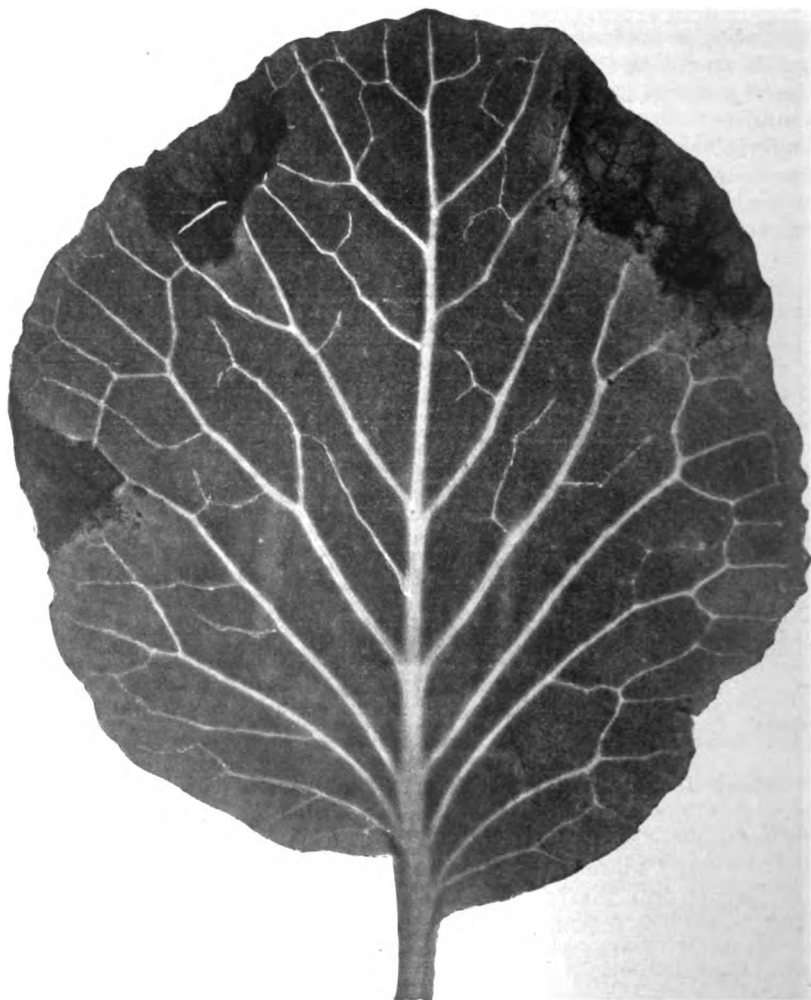


FIG. 6.—Cabbage Leaf affected with Black Rot, Water Pore infection. (Stewart and Harding. New York Station Bulletin No. 232.)

disease, the leaves show a withered, dried appearance along the margin followed by a yellowing in time. The small ribs that lead to the mid rib are usually blackened first and ultimately the larger ones and the mid rib succumb. On cutting across the stem of an infected leaf or sick stalk, one can see the blackened ends of the fibrous strands, known as the fibro vascular bundles, which lead from the stalk out into the

leaf and supply it with water and soil foods. A microscopic examination of these vascular bundles will show the tiny tubes of which they are composed to be alive with germs. As soon as these food and water channels are destroyed, the blade of the leaf is no longer able to get the subsistence required and dies. Diseased leaves usually fall prematurely, leaving a long naked stalk with a tuft of leaves at the tip. The old leaf scars will show the ends of blackened strands corresponding to the diseased fibro vascular bundles in the leaf.

It has been found* that the most common method of infection in the field is through the very small water pores scattered over the blunt teeth on the margin of the leaf. It is by these water pores that a part of the soil moisture that is taken up by the root system escapes from the plant as water vapor but if the surrounding atmosphere is very moist, there will be no evaporation and the water will be seen to accumulate in tiny droplets just over the pores. However, if the soil is very dry, even though the air is moist, we do not have these water beads formed. They can be seen frequently in the early morning on the surface of the leaves and are frequently mistaken for dew. It must be borne in mind that the air is always filled with dust and numerous bacteria and among these there are almost certain to be the germs of black rot, especially if the wind is blowing over a sick field carrying with it fragments of rotting plants and infected soil. These germs are in the beads of moisture, referred to above, and finding a comfortable lodging place and abundant food and water supply, they multiply very rapidly and being able to move about, soon find their way down through the water pores into the veins of the plant. Here they continue to multiply and work toward the stalk leaving behind them the blackened veins and withered blades. The germs may also gain entrance by means of the bites of gnawing insects and again by way of the broken roots at the time of transplanting.

There is no question but that in many cases the plants are taken from the seed bed in a diseased condition and when transplanted into the field spread the germs through the soil rendering it unfit for cabbage growing in the future. When the source of the infection is confined to such a limited space as the seed bed, it is possible to sterilize the soil to a depth of five or six inches by covering it with brush and cord wood and burning it, the heat produced penetrating sufficiently deep to kill most of the surface bacteria as well as troublesome weed seeds. This is a very common practice with tobacco growers and has met with great success wherever employed. If this is not practicable, the seed bed should be located in a new place each year and where cabbage has never been grown. It is only reasonable to suppose if your plants are in a good vigorous condition when transplanted into a "healthful" field, their chance of living is vastly greater than if sick from the start.

When stable manure is used for fertilizer, every precaution should be taken to keep infected cabbage refuse from getting into the manure for in this way the whole heap will become infected with the rot germs and when it is spread on the field the entire plat will become inoculated. One of the worst plant disease epidemics on record was caused in this very way. The writer refers to the present watermelon wilt in North Carolina, South Carolina and Georgia, where melon growing for the

past two years has been practically abandoned by the smaller producers because of the ravages of the wilt. The only safe way to dispose of refuse is to burn it.

It has been demonstrated experimentally by Harding,* Stewart and Prucha that the cabbage seed itself is contaminated with the black rot germs, that some of them could live over winter on the seed and become the source of infection to the young cabbage plants. They advise disinfecting the seed before sowing by soaking it in a 1-1000 solution of corrosive sublimate† for fifteen minutes or in formalin, one pound in thirty gallons.

The removal of sick leaves in the early stages of the disease is practiced by some growers with success. Others have tried this preventative and found it to be a complete failure. The recent investigations of Stewart‡ and Harding condemn this practice and prove quite conclusively that the method is not only harmful to the plants but also worthless. The treatment fails, they say, because

“The removal of so many leaves checks the growth of the plants; infection occurs by way of the roots as well as through the leaves; infection may occur at the base of the leaf close to the stem and get into the stem unobserved; the germs of the disease are so widely and so abundantly distributed that it is useless to try to stamp out the disease by the removal of diseased material.”

Warm days, cool nights and frequent showers seem to accelerate the rot. Smith§ is inclined to think that cabbage planted late is less susceptible than that which is planted early. In selecting cabbages for producing seed the following season, care should be taken to pick out only those which are absolutely free from the infection.

When cabbage is to be stored over winter, the heads should be examined critically and any diseased ones rejected or kept by themselves. The room or store house must be kept cool, below 40° F., and must have uniform ventilation.

It is a matter of common observation that when cabbage is grown year after year on the same piece of land, there is a notable increase in the amount of rot. In the first place, such a method is not to be recommended from an agricultural standpoint since it violates the important principle of crop rotation and further, if it becomes necessary, because of limited space, to continue using this land, our only hope of getting rid of the disease is to grow crops other than members of the cabbage family for five or ten years and longer. During this interim the land must be kept free from all cruciferous weeds which harbor the bacteria, especially from the common wild mustard.

If possible, cabbage should be set each year on ground which has not been planted to it for some time or which has been in sod several seasons or else cultivated to crops which are not affected by the rot. The one important thing for the gardener to observe if he would be a successful cabbage grower, is to take the utmost care to keep his field from becoming infected, and if once infected not to spread the malady over his whole farm.

* Bulletin 251, N. Y. Exp. Sta.

† Corrosive sublimate, 1 part; hydrochloric acid, 2 parts; water 1000 pts.

‡ Bulletin 232, N. Y. Exp. Sta. (1903).

§ Loc. Cit. pp. 12

WILT OF THE CUCUMBER, MUSKMELON AND SQUASH.

This disease of the Cucurbits does the most damage early in the season when the vines are just beginning to run. Sometimes, however, seedlings succumb to the infection while again the wilt does not appear until the vine is in full bearing. Such an instance was observed in the cucumber forcing house at the college this spring. The vine was apparently healthy and doing well when suddenly the leaves began to wilt as if from lack of water or too much hot sun. There was no drying or shriveling of the leaves and in two days the plant was dead. A microscopic examination of a cross section of the vine and larger roots showed the vascular bundles to be plugged with bacteria. No fungi were found and there was no indication of insect work on the roots.

The writer has observed the same wilt on the muskmelon. The symptoms here are the same as for the cucumber as are also the symptoms for the squash; sudden wilting as from lack of water caused by the clogging of the watertubes, followed by prostration and death. Usually one runner will die at a time, beginning at the tip and working back toward the root. Growers seem to think the wilt is worse during wet weather and just after a heavy rain, especially if the sun comes out very hot. Spraying is useless and preventative measures suggest pulling up the sick vines and burning them. The suggestions given for the prevention of potato blight will apply here also. Plant on new land as far as possible and avoid the use of fields which have shown the infection. Rotation of crops is also advised.

Smith* ascribes the wilt to a bacillus† which he believes is carried from diseased to healthy plants by the cucumber beetle and squash bug, hence the necessity of destroying these insects.

SOFT ROT OF THE SUGAR BEET.

This disease was first described and the specific germ‡ isolated by Metcalf and Hedgcock§ in 1902. Beets affected with the rot show the lower half badly decayed and the rotten part honeycombed with "pockets" or cavities filled with a slimy, stringy fluid, colorless and sour smelling. The vascular bundles remain intact while the tissue surrounding them is usually consumed. The normal color of the beets differs so that it is difficult to give any hard and fast color characteristic, but when affected the tissue first shows a yellow, changing to a clay color or gray; later these colors gradually darken. In some cases beets that are badly rotted show no discoloration while others in the early stages are very dark. Above ground the beets appear normal.

* Proc. Am. Asso. Ad. Sci. 1895, pp. 190.

† *Bacillus tracheiphilus* (Smith).

‡ *Bacillus teutillum* (Metcalf).

§ Seventh Annual Report, Neb. Exp. Sta. (1904).

A microscopic examination of viscid liquid that fills the cavities of the rotting tissue shows millions of bacteria, which when grown later in pure culture and inoculated into healthy beets produced symptoms typical of the disease.

The germs gain entrance into the beet through wounds and abrasions in the skin and there is good reason for believing that nematodes are responsible for many of the inoculations. So far as experimental work goes, there is no evidence that infection can take place except through cuts or scratches in the outer surface of the root. In the field, the disease has been observed to progress most rapidly under warm and wet conditions; more mature beets are affected more severely than the younger ones, probably due to the larger amount of sugar present.

If the beets are stored in silos and rotting sets in, they should all be inspected and the decayed ones put in a pile by themselves so that all will not contract the rot. Cold storage does not seem to have any influence on checking the trouble, for even at low temperatures the germs continue to grow and produce havoc. It is recommended* that beets from sick soil be thoroughly sunned and dried before storing, inasmuch as the desiccation and sunlight have been found to be very detrimental to the growth of the germs.

Prevention is the only remedy that can be suggested at this time. Grow your beets on relatively dry ground, if possible and plant corn or some other suitable crop on your former beet ground where the excess of moisture can do no harm. Our greatest hope of controlling this disease as well as others is by breeding up some resistant variety and by careful selections secure a strain which can be planted on wet land and yet remain immune. There is no question but that such resistant varieties will be forthcoming in the near future now that the scientific world is so wide awake to the wonders of plant breeding.

BLIGHT OF THE IRISH POTATO, TOMATO AND EGG PLANT.

It has been shown† by Dr. E. F. Smith that a single species of bacteria‡ has the power of producing blight in a number of plants of the potato family. Among the cultivated ones may be mentioned the Irish potato, tomato, egg plant and pepper. Several common weeds such as the horse nettle, jimson weed and ground cherry are also susceptible to the disease. However we are especially concerned with the disease as it occurs in our common garden vegetables.

The blight manifests itself in the vines by a sudden wilting either of a part or the whole. The stems usually wither, turn yellow and finally black. Young plants appear to contract the disease more readily than old ones. By cutting across the affected stem one can see the characteristic brown or black woody tissue in which the bacteria are at work

* Cent. f. Bakt. II Ab. Bd. VII.—1 & 2.

† Bulletin 12 Div. Veg. Path. U. S. Dept. of Agr.

‡ *Bacillus solanacearum* (Smith).

The tubers from sick plants show a distinct ring of discolored tissue a short distance from the outside of the potato.

Fungicides are of no value in treating the disease and prevention is the only remedy. Do not use diseased tubers for planting and avoid planting on potato sick land as well as on land which has had diseased tomatoes or egg plants.

The symptoms of the blight in the tomato and egg plant are much the same as those for the potato. The vines wilt as if suffering from too hot sun or lack of water. Decay of the stems and branches soon sets in, resulting in the destruction of the plant.

Here, too, spraying has been found useless for the cause of the disease is deep seated within the tissue and beyond the reach of any germicide. Insects, undoubtedly, play some part in carrying the germs from plant to plant and thus spread the trouble, but the soil seems to be the principal medium of infection. What has been said in connection with the potato may be said about planting tomatoes and egg plants on land that has had diseased specimens of the potato family.

If the disease is not too general, it is possible to control its spread by removing the dead vines with the roots from the field and burning them. It is of utmost importance that the vines be destroyed and not thrown down carelessly to start the disease in a healthy part of the field. Remember that you are dealing with a contagious disease and it is your duty to keep it from spreading. One sick vine in your field this year may mean the loss of half your plants next year. Numerous cases have been reported where soil diseases have been carried from farm to farm, up and down the road by the infected mud that adheres to the wagon wheels. The greatest care should be exercised in plowing and cultivating not to drag sick vines over healthy soil for by so doing the disease is spread and what might have been a mild attack is aggravated to such a degree that a general epidemic results. Tools should be thoroughly cleaned before going from an infected field into one free from the disease and as a further precaution, they should be disinfected by washing or dipping them into a 5% solution of either carbolic acid or copper sulphate, commonly known as blue stone. It is important that the gardener's shoes as well as those of his horse be free from clumps of infected soil before going into a new field.

There is a common practice among some farmers of hauling the soil that has washed down a hillside back up onto the shallow places of the farm. If this is done, one should be very certain that the hillside from which this soil has washed is free from all plant diseases, for the writer is familiar with several instances where infection has been spread over healthy land in this way.

Where no remedy can be given, it is clear that our only hope of controlling a disease is by preventing its spread. By observing the foregoing suggestions, it is believed that the most serious plant disturbances can be entirely prevented or at least controlled.

NOTE.

It is earnestly desired that the farmers and gardeners of the State of Michigan will coöperate with this department in furthering the study of bacterial plant diseases by reporting all diseases of this nature that may come under their notice and also by sending in specimens of suspicious material for examination. Wherever possible the whole plant should be sent, for usually root, stem and leaf are required for a satisfactory diagnosis. Address all of your communications relative to suspected bacterial plant diseases,

THE DEPARTMENT OF BACTERIOLOGY AND HYGIENE,

Michigan Agricultural College,

Agricultural College, Michigan.

1881-1882

BULLETIN 231

JUNE, 1905


MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

**DEPARTMENT OF BACTERIOLOGY
AND HYGIENE**

SUGGESTIONS CONCERNING LEGUME INOCULATION

[Popular.]

BY

LAWRENCE T. CLARK.

**AGRICULTURAL COLLEGE, MICHIGAN
1905**

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

MICHIGAN AGRICULTURAL EXPERIMENT STATION

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L. T. CLARK, B. S., - Asst. in Bacteriology	In charge South Haven Station.
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SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.

SUGGESTIONS CONCERNING LEGUME INOCULATION.

LAWRENCE T. CLARK.

The soil of many farms in Michigan, as well as in other states, especially in the older states, is becoming depleted, and among the exhausted elements nitrogen is one of the most difficult to recover. The principal means of recovering nitrogen to the depleted soils are: First, the application of barnyard manure; second, the use of commercial fertilizers; third, the growing of leguminous crops, which, if infected with nitrogen-fixing bacteria, take nitrogen from the atmosphere and store it within the plant. The supply of barnyard manure is inadequate to make up for the losses of nitrogen occasioned by ordinary cropping; the supply of the mineral salts of nitrogen contained within the commercial fertilizers is rapidly becoming exhausted, hence too expensive to be used with profit; finally, this brings us to the growing legume, the nitrogen-fixing bacteria, and the atmosphere as a feasible solution of this serious question.

Since 1884 to 1886 it has been definitely known that legumes, possessing nodules on their roots, have the power to take nitrogen from the atmosphere and make use of it in the actual growth of the plant. Plants possessing these nodules or an internal infection without the formation of nodules, were found to be the only ones capable of this action. The organism or germ present within the nodule and root was found responsible for the formation of such enlargements, and also for collecting and transforming the nitrogen into an available form.

Owing to the fact that these nodules would form only in soils infected with the nodule producing organism, it is impossible to grow legumes, possessing such nodules, in soils where that particular legume or one closely related, has not been previously grown and the proper organism distributed. However, a complete inoculation is made possible by a persistent seeding of one field to the same legume. The nodule-forming bacteria are carried in small numbers on the seed from their respective hosts, consequently, by the application of one kind of seed to the same field year after year a quantity of the germs is distributed, which, together with those which have already developed on the host of the previous season's planting, finally succeed in affecting a uniform inoculation over the entire field. This manner of securing a successful inoculation, although a rather long and expensive one, has proved itself a certain one in several cases that have been called to our attention.

The effect of a previous successful inoculation, although upon a different species of legume, is coming to be considered beneficial to the succeeding legume. For example, a thoroughly inoculated plot of vetch was plowed under at the College Experiment Station in May, 1904, and the plot sowed with uninoculated alfalfa. In May, 1905, this same

plot was again plowed up, exposing the alfalfa roots which were heavily laden with clusters of nodules not unlike the typical vetch nodules. Another interesting feature of this observation was the existence of these clusters not along the stem, as is usually true with alfalfa nodules, but at about the depth of the first plowing and on rootlets running out to a considerable distance from the main root. This is only one of several instances noted that suggests that some benefit is to be derived from one legume following another.

Soil, taken from a field upon which nodule-laden legumes had been grown for some years with success, was first used as a means for distributing the proper organism. This method usually proves very satisfactory from the standpoint of securing the required inoculation, but it has its objectionable features. The expense incurred in shipping and applying sufficient quantities of the germ-laden soil to secure thorough inoculation is often high and the true germ content of such soil is often questionable. These objections, however, are counteracted to quite an extent by the effectiveness of the method. It is still being employed and is serving at present as well as any method.

In 1898, Nobbe conceived the idea that inoculation might be brought about by using pure cultures, grown upon an artificial medium. He put his idea into practice and sent out cultures of the organism isolated from each kind of legume. These cultures were distributed in bottles on a nutrient medium. The use of these cultures in Germany gave many favorable results. A new field had been opened, a broader field, perhaps, than scientific men at that time realized. Tests with his cultures were also made in the United States, with a less degree of success than had been met with in Germany, but it failed to receive general support because of the questionable results.

It was not until the work of Dr. George T. Moore of the Laboratory of Plant Physiology, Department of Agriculture, Washington, was given to the public that general interest in this subject was again aroused. The material previously mentioned, sent out by Nobbe of Germany, was a culture grown and distributed upon a nutrient agar containing nitrogen. Dr. Moore aimed to cultivate the organism on a nitrogen-free medium and by so doing claims to have succeeded in developing a culture that is possessed of greater vigor, both in producing the infection and in storing up free nitrogen. The cultures prepared in this way were distributed to a large number of farms throughout the United States and the results obtained by their use upon seed, given in Bulletin No. 71, Bureau of Plant Industry, show successful inoculation and increase in productiveness in 76 per cent of the cases tried, barring a large number of cases reported as failures due to unfavorable conditions, including poor seed, poor seasons, weed growth, etc.

Closely following the apparent success achieved by Dr. Moore's cultures, several commercial establishments placed inoculating material upon the market. The merits of such cultures have not been established and they are not controlled by the Government, consequently their real value is unknown. The person who invests in such cultures is doing so entirely at his own risk—is taking a leap in the dark; by paying a large price to try an experiment in which the actual possibilities of gain have not been firmly established, he renders himself subject to utter failure as well as possible success.

Inoculating material, without question, will produce the desired infection when applied under favorable conditions. What these favorable or unfavorable conditions are, we are unable to indicate satisfactorily, for it should be remembered that although ideas are formulating, we are still in the first stages of the work and it would be presumptuous to establish fast lines and binding conditions. Such application of inoculating material, from an experimental standpoint, in pots under glass and in small plots in the field, can be carried out very successfully and very flattering results are obtained. Naturally enough, workers are led to expect similar returns from their efforts when directed to larger areas and in a practical way, forgetting the number of unknown conditions which creep in. It is difficult also to determine whether fields require these inoculations or not, since not only the constituents of the soil, the weather elements, and drainage enter for consideration, but the very history of a field must be consulted. The idea in mind when legumes are sown is to increase the fertility by adding nitrogen and humus, and this can be done only by conforming to the controlling influences concerning which we are in such dense ignorance.

In Table II of Dr. Moore's Bulletin No. 71, where "Reports of Experiments with the Principal Leguminous Crops" are given, we find one column, No. 3, which contains, "Failures definitely ascribed to bad season, poor seed, weed growth, etc." Out of 2,502 reports upon alfalfa, red clover, garden pea, common bean, cowpea, soy bean, hairy vetch, crimson clover, field pea, velvet bean, alsike, sweet pea, and berseem, 574 were failures due to the above named causes, while 339 showed no evident advantage from inoculation. From a practical standpoint the failures, of whatever nature, should be considered as such in demonstrating to the public what the real values of this inoculating material are. On the other hand, when we can tell with precision the exact conditions under which inoculating material will prove successfully effective, we shall have solved the question in as satisfactory a manner as we now hope to be able to do. Our efforts, at present, are directed along this line with this end in view.

Through the results published by Dr. Moore in Bulletin No. 71, and from popular articles appearing in agricultural papers and journals, much injudicious enthusiasm has been aroused in this matter which portends trouble for the agricultural public through no fault of its own, because it is in no position to interpret these articles correctly. Information of this character given out to these eager rural peoples by overzealous progressive writers is of a nature to be severely criticised. Exaggerated and misleading articles have appeared, based entirely upon results obtained from limited conditions. The effect of such statements has been very annoying and perhaps detrimental to the subsequent solution of this yet perplexing problem. A still more serious effect, perhaps, is that the expectations of a less conservative rural public are wrought up to such a pitch as to look for results entirely beyond reason, and to regard it as a panacea for all crop failures. This is due in a certain degree to a lack of knowledge of the real powers of these micro-organisms and their limitations.

It is essential to bear in mind that the use of inoculating material as a means for definite gain is in the experimental stage only. Practically all the results upon which we can base any stress are confined to

limited efforts during a very brief period. Until this work has been confirmed and the conditions for manipulation, control, and growth learned, both favorable and unfavorable results must be expected and judgment suspended.

As implied, the enthusiasm created by various misinformed writers has led the farmer to expect too much from the use of inoculating material from whatever source it may be obtained. It is our purpose to caution against undue haste in the matter unless farmers are willing to look upon it as an experiment rather than something established. With this end in view, plots have been secured in different sections of our State, on representative soils, to be used for determining the efficiency of pure cultures of the nitrogen-fixing organism in connection with legumes. Inoculated and uninoculated seeds of alfalfa, June clover, soy beans, and cowpeas were sowed on these plots and results favorable or otherwise will be looked forward to with great interest.

Along this same line Director C. D. Smith, who initiated this work at the Station, is continuing with experiments in testing inoculating material from different sources, different methods of inoculating, in fact, covering many practical phases of this work and he, with F. W. Robison, has already embodied very valuable results in Bulletin No. 224, in which is discussed among other things, the effect of inoculation upon the chemical constituents of the mature plant.

With the combined efforts of Professor Smith and the workers in this department, and also the work carried on elsewhere, results are looked for in the near future that will enable us to say more definitely under what conditions and to what extent we can expect inoculating material to be beneficial.

Many requests for the coveted inoculating material were received early in the winter of 1905. These demands made it necessary to take the matter up at once and if possible determine for the benefit of the farmer, as well as for ourselves, the advisability of distributing inoculating material.

The work of isolating and cultivating these micro-organisms was begun early in January and cultures to be used later upon seed for the field were developed as directions indicate in the following technical portion of this Bulletin. Facts concerning the life history of these micro-organisms may prove beneficial to the farmer in his manipulation of the germs and in understanding their nature.

To secure a culture of this organism free from contamination, the following methods are employed by the writer:

Method No. 1.

- I. Wash nodule free from soil.
- II. Place in a 1:500 solution of acid mercuric chloride for two minutes.
- III. Rinse in sterile water and dry between folds of sterile filter paper.
- IV. Hold nodule with flamed forceps and cut open with flamed knife edged platinum needle.
- V. Make transfer with flamed straight needle to melted media.

- VI. Make two single loop dilutions from original transfer tube and plate. Set plates in temperature room at 25°C., if possible.
- VII. After colonies appear (24-72 hours) isolate organism from characteristic branched colony to slant tubes and into liquid media. Note—The characteristic branched colony will predominate over any possible contaminations in plates.

Method No. 2.

To be recommended when nodules are very small. Wash, sterilize, rinse, and dry as in I, II, and III, Method No. 1.

- IV. Place nodule between flamed one-half cover slips and press slips firmly together.

- V. Transfer these slips into tube of melted media and break them apart with sterile platinum needle.

Make proper dilutions, grow, and isolate as in VI and VII, Method No. 1.

Both methods have been found, in our work, to be very satisfactory in isolating a pure culture.

The final step is to establish the supposed identity of a culture thus isolated. To do this, we employed the following method:

Seedlings of the species of Leguminosae from which the organism in question was isolated, were grown in sterile quartz and watered with a dilute sterile soil solution. As soon as the first pair of leaves were formed, a 24-hour liquid culture of the isolated organism was poured about the stems of seedlings in one pot; a second pot, without pure culture, being kept for control.

If culture is true to name, nodules will appear within 14 days after inoculation.

In our work, better results were obtained when nodules were collected from nearly mature plants. The reason for this is not determinable at present with us. After the circulation in the plant ceases, the centres of the nodules rapidly break down into a doughy mass, hence the necessity for collecting nodules for future use, before this stage is reached, becomes apparent.

Special culture media best serve the purpose for cultivating this organism satisfactorily, although it will grow well on nutrient agar and in bouillon. Various combinations have been tested by Mr. H. F. Tuttle and myself, the following proving most satisfactory:

- I. Extract 450 gr. beef with 1000 cc. lime water.
- II. Strain out meat and boil extract down to 500.
- III. Add 1% peptone and dissolve.
- IV. Add 1½% agar predigested in 500 cc. distilled H²O.
- V. Establish acidity at 8°+, cook one hour, and filter. Tube and sterilize.

Two per cent glucose added to this medium permits a more rapid growth, but a fermentation takes place in slant cultures and interferes with a characteristic growth. One other, however, gave good results, and might well be mentioned:

Ordinary beef extract	1,000.0 cc.
NaCl	5.0 gr.
MgSO ₄	0.1 gr.
KH ₂ PO ₄	0.5 gr.
Maltose	15.0 gr.
Agar	15.0 gr.
Acidity established at.....	8°+

Although the beef extract used in this formula contains approximately .11% N, this amount is considerably lower than that in media to which peptone has been added as a nutritive element, consequently this medium comes nearer to the class of nitrogen-free media than the previous one, which contains peptone.

When a culture is desired for securing inoculations upon soil or seed, the organism should be isolated from the plates at once to a nitrogen-free nutrient solution, where growth takes place more slowly, but where the nitrogen assimilating power is retained and increased, according to Moore. Among a number of nitrogen-free preparations tested, solutions A and B as follows, gave the most luxuriant growth:

Solution A—

Glucose	36.21 gr.
MgSO ₄	.18 gr.
KH ₂ PO ₄	3.62 gr.
Tap water	3,621 cc.

Solution B—

Glucose	10.0 gr.
Mg(PO ₄) ₂	.5 gr.
Top water	1,000.0 cc.

The range of temperature at which this organism will grow is quite wide, being from 7°C. to 38°C. 25°C., however, is the temperature best suited to a luxuriant, characteristic development. Above 25°C. very rapid drying out of the culture takes place. This is especially marked in slant agar cultures where a wrinkling of the growth also ensues, which interferes with the development of branched forms and also with the vitality of the organism.

Variation of temperature, with absence of moisture, has little or no effect, however, upon the vitality of the organism when within the nodule itself. To establish this fact, a number of sound cowpea nodules were collected in October, 1904, washed sterilized with 1:500 HgCl₂, as for isolating, and then dried under sterile conditions. Three of these nodules of a uniform size were then selected and placed one each in sterile tubes numbered 1, 2 and 3.

A culture was made from No. 1, and motility, number, and cultural vitality of the organism noted. The remaining tubes, Nos. 2 and 3, were placed near steam connections at a temperature of 40°C. In 21 days No. 2 was tested in the same manner as No. 1, and after 42 days No. 3 was tested as were Nos. 1 and 2. The results of these tests showed that the constant high temperature had no apparent detrimental effect on the vitality, motility, and number of organisms present.

Parallel with the above experiment, cultures were grown on solid artificial media, in tubes, at a temperature of 37.5°C. for 21 and 42 days respectively. A heavy growth occurred which soon became dry and shriveled, and when transfers were made to fresh media at the end of 21 and 42 days, the organism made a slow, weak growth, possessing but little vitality. This weakened condition was remedied by making a series of transfers on fresh media at a temperature of 25°C.

The effect of freezing has not been fully worked out, but the following observation shows that the organism, when left within the nodule as it grew in the field, has considerable resistance to frost. On March 25, 1905, a nodule-laden root of soy bean was pulled from an inoculated experimental plot at the College. Some of these nodules were still intact, and contained a very active culture of the soy bean organism. The hanging drop revealed marked motility and plates made from the same nodule developed the characteristic tree-like colony.

The colony first appears as a small, round spot, which soon grows up through the medium to the surface. Upon reaching the surface, it spreads out at a very rapid rate, and takes on a peculiar characteristic tree-like form. If colonies are crowded in the plate, this characteristic growth is not so apparent and one might question the source of a thick plate, while the greater dilution plate would develop the colony true in character.

Because of the rapid spreading peculiar to this colony, fewer contaminations are met with if greater dilutions are made from the original tube which contains the nodular material.

Colonies from different species of legumes vary but little in general appearance. Some minor differences exist, however, that can be detected only when a comparative examination is made. Those from the clovers are very similar, as are those of the cowpea and soy bean. Slight differences exist, however, between the colonies from these two classes.

After the organism is once isolated to artificial media, it is desirable to maintain and increase its vitality, if possible. To attain this end in our work, the organism was transferred to slant agar tubes of peptone-free media, and grown at a temperature of 25°C. for 48 hours. The tubes were then removed to a temperature of 16°-18°C. and allowed to remain. Under these conditions the culture remains fresh and actively vital for a much longer time than if grown in media rich in nitrogen at a higher temperature.

Associated with the old cultures grown as indicated above, we find the large rod and branched forms. The branched forms are peculiarly branching micro-organisms resembling the letters "T," "X," and "Y." In our investigations we have found these forms in old cultures only, and on media deficient in and entirely devoid of nitrogen. Their presence was demonstrated by making a series of stains from 1-15 and 30 day cultures, respectively. The 24-hour culture possessed the minute rod forms only. In the 15-day culture, several of the large rod and branched forms were present, with the minute rod forms in the majority. In the 30-day culture, the large rod and branched forms were quite numerous.

According to Moore, the assimilation of atmospheric nitrogen is attributed to the large rod forms which eventually become transformed into the branched forms, and in the nodule the branched forms only can

be acted upon by the plant juices. Because of the close relationship between the occurrence of the large rod forms and branched forms, as demonstrated by our own work, it is questionable whether any distinct line can be drawn between the nitrogen-assimilating power of these two forms.

I have attempted to point out the requirements necessary for the successful cultivation and study of the organism in question. Although the work with this particular organism is in a very tentative stage, much is being done at present to determine its true economic importance. For success in practical field experiments, much depends upon the cultural manipulations in producing inoculating material. At present this work is progressing successfully in our laboratory, and we hope in the near future to say definitely what can be done with this organism nature has so fitly supplied to benefit leguminous plants.

Laboratory of Bacteriology and Hygiene, June 29, 1905.

Sci 1635.15.3

BULLETIN 232

JULY, 1905

MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

— —

CHEMICAL DEPARTMENT.

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FERTILIZER ANALYSES

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BY

ANDREW J. PATTEN

—

AGRICULTURAL COLLEGE, MICHIGAN
1905

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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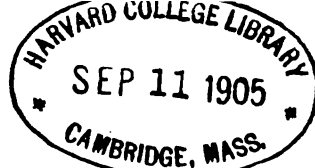
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H. FOLLEY TUTTLE, B. S., Asst. in Bacteriology	In charge South Haven Station.
MRS. L. E. LONDON - - - - - Librarian	

SUB-STATIONS

Grayling, Crawford County, 80 acres deeded. Abandoned.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County 160 acres deeded.



The Station
FERTILIZER ANALYSES.

ANDREW J. PATTEN, CHEMIST.

The inspection and analyses of the commercial fertilizers offered for sale in Michigan are made under authority of an act of the Legislature approved March 10, 1885. The full text of the law is again printed since many inquiries are continually received concerning it.

SECTION 1. *The People of the State of Michigan enact*, That any person or persons who shall sell or offer for sale in this State any commercial fertilizer, the retail price of which exceeds ten dollars per ton, shall affix on the outside of every package containing such fertilizer a plainly printed certificate, stating the number of net pounds therein; the name or trade mark under which such article is sold; the name of the manufacturer; the place of manufacture, and a chemical analysis, stating the percentage of nitrogen in an available form; of potash soluble in water and of phosphoric acid in available form (soluble or reverted) and the insoluble phosphoric acid.

SEC. 2. Before any commercial fertilizer is sold or offered for sale, the manufacturer, importer or party who causes it to be sold or offered for sale within this State, shall file with the secretary of the State Board of Agriculture a certified copy of the analysis and certificate referred to in section one, and shall also deposit with said secretary a sealed glass jar containing not less than two pounds of such fertilizer, with an affidavit that it is a fair sample of the article thus to be sold or offered for sale.

SEC. 3. The manufacturer, importer, or agent of any commercial fertilizer, the retail price of which exceeds ten dollars per ton as aforesaid, shall pay annually to the secretary of the State Board of Agriculture, on or before the first day of May, a license fee of twenty dollars for each and every brand of fertilizer he offers for sale in this State: *Provided*, That whenever the manufacturer or importer shall have paid this license fee his agents shall not be required to do so.

SEC. 4. All such analyses of commercial fertilizers required by this act shall be made under the direction of the State Board of Agriculture and paid for out of the funds arising from the license fees provided for in section three. At least one analysis of each fertilizer shall be made annually.

SEC. 5. The secretary of the State Board of Agriculture shall publish in his annual report a correct statement of all analyses made and certificates filed in his office; together with a statement of all moneys received for license fees, and expended for analysis. Any surplus from license fees remaining on hand at the close of the fiscal year shall be placed to the credit of the experimental fund of said board.

SEC. 6. Any person or persons who shall sell or offer for sale any commercial fertilizer in this State without first complying with the provisions of sections one, two, and three of this act, or who shall attach or cause to be attached to any such package or fertilizer an analysis stating that it contains a larger percentage of any one or more of the constituents or ingredients

named in section one of this act than it really does contain shall, upon conviction thereof, be fined not less than one hundred dollars for the first offense, and not less than three hundred dollars for every subsequent offense, and the offender shall also be liable for damages sustained by the purchaser of such fertilizer on account of such misrepresentation.

SEC. 7. The State Board of Agriculture by any duly authorized agent is hereby authorized to select from any package of commercial fertilizer exposed for sale in this State, a quantity, not exceeding two pounds, for a sample, such sample to be used for the purposes of an official analysis and for comparison with the certificate filed with the secretary of the State Board of Agriculture and with the certificate affixed to the package on sale.

SEC. 8. All suits for the recovery of fines under the provisions of this act shall be brought under the direction of the State Board of Agriculture.

Twenty manufacturing firms have registered for sale in this State, during 1905, 120 different brands of fertilizers.

Of these various brands, 82 are complete fertilizers; of the others, 12 contain phosphoric acid and potash, without nitrogen; 11 contain phosphoric acid and nitrogen without potash; 12 contain phosphoric acid only; 2 contain potash salts only and 1 contains nitrogen only.

The Station has attempted, through its collecting agent, Mr. E. A. Boyer, to obtain samples of all these brands upon the open market but in many cases it was not possible to find them. Unless otherwise indicated the analyses herein reported were made on the collected samples.

The analyses on the whole are very satisfactory for in but a few cases do the percentages found fall far below those guaranteed, and it is quite evident that no wilful attempt has been made to defraud. However some evidences of uneven mixing are apparent. Prospective buyers would find it much to their benefit to carefully study the accompanying tables before making large purchases. The following is a partial list of persons and places where fertilizers were found on sale this spring.

Adrian—Nathan Smith & Son.

Albion—F. Steele.

Bay City—Jenison Hardware Co., R. C. Bialy, F. C. Goodine, Presley & Laver, G. H. Mosher, Mohr Hardware Co.

Belding—Weiter, Wise & Co.

Benton Harbor—B. N. Nowlen & Co., H. E. Boehn.

Birmingham—E. R. Smith & Co.

Bad Axe—Wright, Freemont & Co., Wm. Rapson & Sons.

Butternut—O. W. Wilson.

Caro—Caro Sugar Co.

Carsonville—C. J. Walker, Hartshorn & Anderson.

Chelsea—R. A. Snyder, Lime & Produce Co.

Charlotte—Webster, Cobb Co., Garber & Gibbe.

Clio—J. Wellman & Son, G. W. Hubbard & Co.

Denton—J. B. Schlicht.

Farmington—C. B. Pettibone.

Flint—Dane & Vermilya, Burroughs & Son.

French Landing—Detroit Sanitary Works.

Grand Haven—James Locke, J. A. Franks.

Grand Rapids—Jones Seed Co., Brown Seed Co., Hess & Thompson.

Holland—Keplar & Son, H. P. Zwemer.

Holly—M. N. Hudson.
Ida—Silas Crane, Mr. Snell.
Ionia—Spaulding & Merritt.
Jackson—J. E. Bartlett & Co., S. M. Isbell & Co., Reid Implement & Seed Co.
Kalamazoo—Woodhams Coal Co.
Lansing—H. P. Gladden, Owosso Sugar Co.
Lapeer—Robert King, Chase & Mitchell.
Marine City—Zimmerman Bros.
Marlette—W. H. Wilson.
Milan—W. H. Hack, W. P. Lampkin, Reeves & Son, Fred Hasley.
Mt. Clemens—C. Ancot, John N. Tucker.
Niles—S. E. Bolton.
Owosso—J. Brooks & Son, W. E. Payne & Co.
Petersburg—H. A. Logan.
Pontiac—E. Holland & Sons.
Plymouth—J. A. McLaren.
Romeo—Bliss & Bartholomew, McKay & Co., Hosmer & Powell.
Romulus—J. D. McClarien, T. W. McCloughy.
Royal Oak—Jacob Erb, J. M. Lawson.
Saginaw—Saginaw Beef Co., Saginaw Milling Co.
St. Louis—St. Louis Hardware Co.
St. Joseph—G. R. Pixley.
St. Johns—L. G. McKnight & Co.
Temperance—A. H. King & Co.
Sanilac Center—Wm. & Dell Dawson.
South Haven—Merrifield Implement Co.
Vassar—F. Miller.
Vicksburg—Vicksburg Lumber Co.
Wyandotte—Wyman Coal & Ice Co.
Ypsilanti—C. E. Thompson & Co.
Zeeland—Isaac Van Dyke & Co.

ACKNOWLEDGMENTS.

I desire to acknowledge the efficient assistance of Miss Dorothea Moxness, Mr. J. S. Shaw and Mr. E. A. Boyer, by whom the greater part of the analytical work herein reported was done.

Results of analyses of commerical fertilizers

Laboratory number. X	Manufacturer	Trade Name
*931	American Agricultural Chemical Co., New York....	Bradleys Alkaline Bone and Potash...
838	American Agricultural Chemical Co., New York....	Bradley's B. D. Sea Fowl Guano.....
839	American Agricultural Chemical Co., New York....	Bradley's Dissolved Bone with Potash..
832	American Agricultural Chemical Co., New York....	Bradley's Niagara Phosphate.....
*930	American Agricultural Chemical Co., New York....	Bradley's Soluble Dissolved Bone.....
901	American Agricultural Chemical Co., New York....	Crocker's Ammoniated Bone Super- phosphate.....
*928	American Agricultural Chemical Co., New York....	Crocker's Ammoniated Wheat and Corn Phosphate.....
*947	American Agricultural Chemical Co., New York....	Crocker's Dissolved Bone and Potash..
874	American Agricultural Chemical Co., New York....	Crocker's General Crop Phosphate.....
883	American Agricultural Chemical Co., New York....	Crocker's New Rival Ammoniated Su- perphosphate.....
*929	American Agricultural Chemical Co., New York....	Crocker's Universal Grain Grower.....
933	American Agricultural Chemical Co., New York....	Fine Ground Bone.....
872	American Agricultural Chemical Co., New York....	High Grade Garden and Vegetable Fer- tilizer.....
852	American Agricultural Chemical Co., New York....	Niagara Dissolved Bone and Potash...
854	American Agricultural Chemical Co., New York....	Niagara Grain and Grass Grower.....

*Manufacturers' sample.

FERTILIZER ANALYSES.

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for 1905, expressed in parts in a hundred.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed..... Found.....		11 11.82	 3.55	12 15.37	2 2.03
Claimed..... Found.....	2.06 2.02	8 9.23	 1.35	10 10.58	1.50 1.10
Claimed..... Found.....	1 .97	8 9.50	 3.03	10 12.13	2 2.17
Claimed..... Found.....	.82 .80	7 9.66	 2.66	8 10.06	1 1.21
Claimed..... Found.....		14 14.55	 2.45	15 17.00	.....
Claimed..... Found.....	2.46 2.43	9 12.37	 2.00	10 12.60	2 2.55
Claimed..... Found.....	2.05 2.01	8 10.16	 1.15	9 11.25	1.50 1.57
Claimed..... Found.....		10 12.45	 2.35	11 14.75	2 1.50
Claimed..... Found.....	.82 .85	7 10.36	44	8 10.80	1 1.41
Claimed..... Found.....	1.23 1.33	9 9.07	 3.00	10 12.03	2 2.22
Claimed..... Found.....	.82 .95	8 8.12	 2.59	9 10.62	2 2.35
Claimed..... Found.....	2.47 2.91			22.8 30.04	
Claimed..... Found.....	2.08 1.76	8 8.82	 3.03	 11.90	6 0.38
Claimed..... Found.....		10 10.27	 3.45	 13.72	2 1.98
Claimed..... Found.....	.82 .84	7 8.55	 2.10	 10.65	1 2.02

Results of analyses of commercial fertilizers

Laboratory number, A	Manufacturer	Trade Name
842	American Agricultural Chemical Co., New York.....	Niagara Potato and Vegetable Fertilizer
834	American Agricultural Chemical Co., New York.....	Niagara Wheat and Corn Producer.....
*952	Armour Fertilizer Works, Chicago.....	Acidulated Bone Meal.....
882	Armour Fertilizer Works, Chicago.....	All Soluble.....
*957	The Armour Fertilizer Works, Chicago.....	Ammoniated Bone with Potash.....
*946	The Armour Fertilizer Works, Chicago.....	Banner Brand.....
875	The Armour Fertilizer Works, Chicago.....	Bean Grower.....
*956	The Armour Fertilizer Works, Chicago.....	Bone, Blood and Potash.....
*954	The Armour Fertilizer Works, Chicago.....	Bone Meal.....
823	The Armour Fertilizer Works, Chicago.....	Fruit and Root Crop Special.....
*744	The Armour Fertilizer Works, Chicago.....	German Kainit.....
817	The Armour Fertilizer Works, Chicago.....	Grain Grower.....
818	The Armour Fertilizer Works, Chicago.....	High Grade Potato Fertilizer.....
*763	The Armour Fertilizer Works, Chicago.....	Muriate of Potash.....
*757	The Armour Fertilizer Works, Chicago.....	Nitrate of Soda.....

*Manufacturers' sample.

FERTILIZER ANALYSES.

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for 1905, expressed in parts in a hundred.—CON.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed..... Found.....	2.06 2.56	8 0.25	2.56	9 11.75	3 3.04
Claimed..... Found.....	1.23 1.29	9 0.16	2.40	12.56	2 2.20
Claimed..... Found.....	1.65 2.15			18 26.88	
Claimed..... Found.....	2.88 3.14	8 3.44	3.52	10 11.96	4 4.33
Claimed..... Found.....	2.47 2.48	6 6.98	1.55	8 8.53	2 2.53
Claimed..... Found.....		10 12.27	.60	12 12.87	8 7.51
Claimed..... Found.....	.82 1.10	8 0.78	1.76	10 11.43	2 2.00
Claimed..... Found.....	4.11 4.17	8 0.33	2.95	10 12.23	7 8.22
Claimed..... Found.....	2.47 2.36			24 27.36	
Claimed..... Found.....	1.65 1.52	8 10.28	2.25	10 12.53	5 4.00
Claimed..... Found.....					12 13.44
Claimed..... Found.....	1.65 1.64	8 8.55	2.25	10 11.80	2 3.13
Claimed..... Found.....	1.65 1.03	8 10.14	2.96	10 13.10	10 8.13
Claimed..... Found.....					48 51.34
Claimed..... Found.....	15.63 15.46				

Results of analyses of commerical fertilizers

Laboratory number. A	Manufacturer	Trade Name
*953	The Armour Fertilizer Works, Chicago.....	Phosphate and Potash.....
*951	The Armour Fertilizer Works, Chicago.....	Star Phosphate.....
*955	The Armour Fertilizer Works, Chicago.....	Steamed Bone Meal.....
*950	The Armour Fertilizer Works, Chicago.....	Sugar Beet Special.....
879	The Armour Fertilizer Works, Chicago.....	Wheat, Corn and Oat Special.....
799	Robert Binder, Battle Creek.....	Blood and Bone.....
*893	Buffalo Fertilizer Co., Buffalo.....	Ammoniated Bone Black.....
*889	Buffalo Fertilizer Co., Buffalo.....	Bone Meal.....
*888	Buffalo Fertilizer Co., Buffalo.....	Celery and Potato Special.....
*910	Buffalo Fertilizer Co., Buffalo.....	Farmers Choice.....
*890	Buffalo Fertilizer Co., Buffalo.....	Garden Truck.....
*895	Buffalo Fertilizer Co., Buffalo.....	General Crop.....
*894	Buffalo Fertilizer Co., Buffalo.....	Ohio and Michigan Special.....
*896	Buffalo Fertilizer Co., Buffalo.....	Soluble Bone.....
*891	Buffalo Fertilizer Co., Buffalo.....	York State Special.....

*Manufacturers' sample.

for 1905, expressed in parts in a hundred.—CON.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed Found.....		10 9.93	1.30	12 11.13	2 1.96
Claimed Found.....		14 15.57	.68	16 16.25	
Claimed Found.....	1.65 2.73			20 24.35	
Claimed Found.....	.82 .89	8 8.86	.65	10 9.45	4 4.28
Claimed Found.....	.82 .93	7 11.05	3.44	9 13.49	1 2.04
Claimed Found.....	5.25 5.25			13.17 13.17	.29 .29
Claimed Found.....	1.23 .93	8 8.49	1.36	9 9.85	2.50 1.93
Claimed Found.....	2.46 2.77			25 25.69	
Claimed Found.....	1.64 1.79	7 7.63	2.15	8 9.78	10 10.21
Claimed Found.....	.82 .73	8 8.21	1.25	9 10.46	5 5.53
Claimed Found.....	3.28 2.81	8 9.17	3.30	9 12.47	7 8.36
Claimed Found.....		9 8.59	5.66	10 14.19	3 3.51
Claimed Found.....	.82 .97	11 13.27	2.15	12 15.42	1 2.10
Claimed Found.....		14 18.43	.75	15 19.18	
Claimed Found.....	1.64 1.68	9 9.54	3.80	10 13.34	5 6.30

Results of analyses of commercial fertilizers

Laboratory number. A	Manufacturer	Trade Name
835	Centra City Fertilizer Co., Jackson.....	Blackman Brand General Crop Fertilizer.....
*948	Central City Fertilizer Co., Jackson.....	Blackman Brand Sugar Beet, Onion and Potato.....
862	Chicago Fertilizer Co., Chicago.....	Bone, Blood and Potash.....
918	Chicago Fertilizer Co., Chicago.....	Potash Special.....
870	Chicago Fertilizer Co., Chicago.....	Wheat and Corn Special.....
*934	Darling & Company, Chicago.....	Darling's Acid Phosphate.....
821	Darling & Company, Chicago.....	Chicago Brand.....
846	Darling & Company, Chicago.....	Farmer's Favorite Brand.....
864	Darling & Company, Chicago.....	Darling's General Crop Brand.....
840	Darling & Company, Chicago.....	Pure Bone and Potash.....
886	Darling & Company, Chicago.....	Pure Ground Bone.....
844	Darling & Company, Chicago.....	Sure Winner Brand.....
861	Darling & Company, Chicago.....	Darling's Western Brand.....
915	Grand Rapids Glue Co., Grand Rapids.....	Grand Rapids.....
*925	Grange Fertilizer Co., Detroit.....	Complete Manure.....

*Manufacturers' sample.

FERTILIZER ANALYSES.

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for 1905, expressed in parts in a hundred.—CON.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed.....	1.25	7		9	1.25
Found.....	1.00			14.67	3.61
Claimed.....	2.50	10		10	3
Found.....	2.18	6.38	10.36	16.68	3.66
Claimed.....	1.23	8			2
Found.....	.57	10.68	2.70	13.38	1.53
Claimed.....	.82	8			4
Found.....	2.13	10.20	1.86	12.06	6.23
Claimed.....	.82	7			1
Found.....	.34	16.07	2.46	13.13	.76
Claimed.....		10			
Found.....		11.62	.60	11.62	
Claimed.....	1.65	8		10	2
Found.....	1.37	7.66	5.25	12.35	2.56
Claimed.....	2.47	8		10	4
Found.....	2.41	8.14	7.22	15.36	4.36
Claimed.....	.82	8		10	6
Found.....	.06	0.75	2.45	12.20	5.73
Claimed.....	2.14			20.13	6
Found.....	2.00			22.56	7.00
Claimed.....	2.47			23	
Found.....	2.37			26.95	
Claimed.....	.82	8		10	3
Found.....	.00	7.83	2.65	10.48	3.56
Claimed.....	.41	7		9	.50
Found.....	.58	8.65	1.05	9.70	.93
Claimed.....	2	8		15	1
Found.....	2.34	8.99	12.60	21.59	2.12
Claimed.....	.85	7		8	1
Found.....	.93	16.60	.96	11.50	1.63

Results of analyses of commercial fertilizers

Laboratory number. A	Manufacturer	Trade Name
*924	Grange Fertilizer Co., Detroit.....	Corn, Oats and Grass.....
*926	Grange Fertilizer Co., Detroit.....	Potato and Vegetable Fertilizer.....
*923	Grange Fertilizer Co., Detroit.....	Wheat Fertilizer.....
*927	Grange Fertilizer Co., Detroit.....	Wheat Fertilizer with Potash.....
939	Jarecki Chemical Co., Sandusky, Ohio.....	C. O. D. Phosphate.....
940	Jarecki Chemical Co., Sandusky, Ohio.....	Fish and Potash Grain Special.....
816	Jarecki Chemical Co., Sandusky, Ohio.....	Fish and Potash, Tobacco and Potato Food.....
824	Jarecki Chemical Co., Sandusky, Ohio.....	Lake Erie Fish Guano.....
815	Jarecki Chemical Co., Sandusky, Ohio.....	Number One Fish Guano.....
*937	Jarecki Chemical Co., Sandusky, Ohio.....	Special Sugar Beet Grower.....
938	Jarecki Chemical Co., Sandusky, Ohio.....	Square Brand Phosphate and Potash...
*680	Joseph Lister, Chicago.....	Bone Meal.....
*942	Michigan Carbon Works, Detroit.....	Banner Dissolved Bone.....
847	Michigan Carbon Works, Detroit.....	Dessicated Bone.....
837	Michigan Carbon Works, Detroit.....	Homestead Bone Black Fertilizer.....

*Manufacturers' sample.

for 1905, expressed in parts in a hundred.—CON.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed.....	1.64	8		10	2
Found.....	1.39	9.39	1.70	11.50	2.07
Claimed.....	.85	8		9	4
Found.....	.34	9.20	2.36	11.50	3.17
Claimed.....		14		15	
Found.....		13.47	1.96	15.37	
Claimed.....		10		11	2
Found.....		12.35	2.15	14.50	1.45
Claimed.....		14			
Found.....		13.87	3.66	16.87	
Claimed.....	1.25	9			2
Found.....	1.33	11.27	2.10	13.37	3.04
Claimed.....	.83	8			4
Found.....	.74	10.46	1.85	12.25	3.33
Claimed.....	.83	10			2
Found.....	.33	9.98	2.60	12.58	1.87
Claimed.....	.83	10			1
Found.....	.81	11.15	3.60	14.75	1.21
Claimed.....	.83	8			4
Found.....	.84	10.25	2.09	12.25	5.23
Claimed.....		10			2
Found.....		11.77	3.16	14.87	2.40
Claimed.....	4.68			26.06	
Found.....	1.98			27.61	
Claimed.....		30		32	
Found.....		27.68	6.30	34.48	
Claimed.....	1.24			25	
Found.....	1.47			32.13	
Claimed.....	2.06	8		9	1.50
Found.....	1.65	12.99	.49	13.36	3.86

Results of analyses of commercial fertilizers

Laboratory number. A	Manufacturer	Trade Name
833	Michigan Carbon Works, Detroit.....	Homestead High Grade Garden and Vegetable Fertilizer.....
831	Michigan Carbon Works, Detroit.....	Homestead Potato and Tobacco Fertilizer.....
881	Michigan Carbon Works, Detroit.....	Special Beet Fertilizer.....
820	Michigan Carbon Works, Detroit.....	Homestead Sugar Beet Fertilizer.....
878	Michigan Carbon Works, Detroit.....	Pure Animal Bone and Potash.....
825	Michigan Carbon Works, Detroit.....	Red Line Complete Manure.....
*941	Michigan Carbon Works, Detroit.....	Red Line Phosphate.....
855	Michigan Carbon Works, Detroit.....	Red Line Phosphate with Potash.....
845	Michigan Carbon Works, Detroit.....	Special Fertilizer.....
873	Michigan Carbon Works, Detroit.....	Wolverine Phosphate.....
791	Natural Guano Company, Aurora, Ill.....	Dried Sheep Manure.....
*756	Natural Guano Company, Aurora, Ill.....	Dried Sheep Manure†.....
920	Northwestern Fertilizing Co., Chicago, Ill.....	Garden City Superphosphate.....
865	Northwestern Fertilizing Co., Chicago, Ill.....	Horseshoe Brand Acidulated Bone and Potash.....
921	Northwestern Fertilizing Co., Chicago.....	Horseshoe Brand Corn and Wheat Grower

*Manufacturers' sample.

†Water soluble phosphoric acid: claimed, 1.25; found, 1.18

for 1905, expressed in parts in a hundred.—CON.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed.....	2.08	8			6
Found.....	2.11	8.66	2.13	10.84	6.27
Claimed.....	2.06	8		9	3
Found.....	2.46	9.89	2.39	12.28	3.91
Claimed.....	1.64	9		10	5
Found.....	1.71	9.66	1.69	11.40	5.29
Claimed.....	1.23	9		10	2
Found.....	1.31	10.89	.88	11.77	2.42
Claimed.....	.82			22	10
Found.....	.88			25.00	12.17
Claimed.....	.82	7		8	1
Found.....	1.03	7.40	2.42	10.82	1.34
Claimed.....		14		15	
Found.....		14.22	1.90	16.12	
Claimed.....		10		11	2
Found.....		10.44	2.76	14.26	2.62
Claimed.....				14	10
Found.....				16.53	10.64
Claimed.....		10		11	
Found.....		9.13	2.67	11.80	
Claimed.....	3.25			1.50	1.75
Found.....	2.40			.93	1.79
Claimed.....	3.25			1.50	1.75
Found.....	2.35			2.14	2.18
Claimed.....	2.05	8		10	1.50
Found.....	2.22	8.92	1.45	10.37	2.29
Claimed.....	.82	10		12	1
Found.....	1.07	10.24	2.96	13.20	1.21
Claimed.....	1.64	8		10	2
Found.....	2.53	8.76	2.70	11.40	2.41

Results of analyses of commercial fertilizers

Laboratory number. A	Manufacturer	Trade Name
*935	Northwestern Fertilizing Co., Chicago.....	Horseshoe Brand Potato Grower.....
869	Northwestern Fertilizing Co., Chicago.....	Horseshoe Brand Quick Acting Phos- phate.....
*936	Northwestern Fertilizing Co., Chicago.....	Horseshoe Brand Sugar Beet Fertilizer.
*945	Ohio Farmer's Fertilizer Co., Columbus, Ohio.....	Ammoniated Bone and Potash.....
899	Ohio Farmer's Fertilizer Co., Columbus, Ohio.....	Corn, Oats and Wheat, Fish Guano....
903	Ohio Farmer's Fertilizer Co., Columbus, Ohio.....	General Crop Fish Guano.....
827	Nathan Smith & Son, Adrian.....	Fertiline.....
898	Spedel & Swartz, Grand Haven.....	Celery Hustler.....
*943	Swift & Company, Chicago.....	Ammoniated Bone and Potash.....
*944	Swift & Company, Chicago.....	Swift's Bone and Potash.....
856	Swift & Company, Chicago.....	Onion, Potato and Tobacco.....
826	Swift & Company, Chicago.....	Pure Complete Fertilizer.....
813	Swift & Company, Chicago.....	Pure Sugar Beet Grower.....
819	Swift & Company, Chicago.....	Pure Truck Grower.....
900	Swift & Company, Chicago.....	Special Bone Meal.....

*Manufacturers' sample.

FERTILIZER ANALYSES.

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for 1905, expressed in parts in a hundred.—CON.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed.....	2.46	9		11	2
Found.....	2.57	9.62	1.00	10.62	1.98
Claimed.....		10		12	
Found.....		10.21	2.12	12.43	
Claimed.....	1.23	9		10	2
Found.....	1.28	10.13	.75	11.08	2.11
Claimed.....	.82	8			4
Found.....	.88	10.16	2.15	12.25	2.00
Claimed.....	1.23	8			2
Found.....	.63	9.95	2.55	12.59	2.56
Claimed.....	.82	7			1
Found.....	.28	10.97	2.65	13.62	1.12
Claimed.....	12			25	25
Found.....	12.52			21.46	22.26
Claimed.....	7.50	3.35		4.75	2.25
Found.....	5.63	4.25	.06	5.25	2.94
Claimed.....	4.75			16	3
Found.....	4.49			12.75	2.99
Claimed.....	2.50			23.50	3
Found.....	2.49			26.25	4.77
Claimed.....	1.64	8		11	7
Found.....	1.46	2.52	2.57	12.15	2.92
Claimed.....	1	8		11	1
Found.....	.98	7.21	2.75	11.56	1.26
Claimed.....	2.50	8		11	5
Found.....	2.29	7.95	2.55	11.50	5.66
Claimed.....	.82	8		10	4
Found.....	.27	2.86	2.92	12.72	4.14
Claimed.....	.82			27.50	
Found.....	1.51			26.29	

Results of analyses of commercial fertilizers

Laboratory number. &	Manufacturer	Trade Name
*787	Swift & Company, Chicago.....	Swift's Special Bone Meal.....
802	Swift & Company, Chicago.....	Superphosphate.....
877	Swift & Company, Chicago.....	Swift's Bone Meal.....
814	Swift & Company, Chicago.....	Swift's Pure Vegetable Grower.....
868	Swift & Company, Chicago.....	Special Phosphate and Potash.....
*962	Tuscarora Fertilizer Co., Chicago.....	Acid Phosphate.....
*959	Tuscarora Fertilizer Co., Chicago.....	Ammoniated Phosphate.....
*965	Tuscarora Fertilizer Co., Chicago.....	Bone and Potash.....
*968	Tuscarora Fertilizer Co., Chicago.....	Michigan Special.....
*966	Tuscarora Fertilizer Co., Chicago.....	Steamed Bone Meal.....
*970	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Bone Phosphate.....
*960	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Friut and Potato.....
*967	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Garden.....
*964	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Standard.....
*963	Tuscarora Fertilizer Co., Chicago.....	Tuscarora Trucker.....

*Manufacturers' sample.

for 1905, expressed in parts in a hundred.—Con.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed.....	.82			27.50	
Found.....	.97			33.35	
Claimed.....	1.64	8		12	2
Found.....	1.53	7.19	4.33	11.93	2.24
Claimed.....	2.50			25	
Found.....	2.46			26.33	
Claimed.....	3.25	9		10	10
Found.....	2.89	10.92	3.85	13.37	10.60
Claimed.....		10		11	2
Found.....		10.06	.32	11.48	2.16
Claimed.....		14		16	
Found.....		14.63	.75	15.38	
Claimed.....	.82	7		9	1
Found.....	1.97	7.89	.78	8.58	1.97
Claimed.....		10		12	2
Found.....		11.05	.29	11.25	2.97
Claimed.....	1.65	8		10	5
Found.....	1.39	9.23	.59	9.73	5.15
Claimed.....	1.65			20	
Found.....	2.73			24.53	
Claimed.....		10		12	
Found.....		11.41	.26	11.67	
Claimed.....	1.65	8		10	10
Found.....	1.49	8.59	.85	9.35	5.34
Claimed.....	2.88	8		10	4
Found.....	2.73	8.99	2.33	11.73	4.28
Claimed.....	1.65	8		10	2
Found.....	1.39	8.52	1.63	10.15	2.12
Claimed.....	4.11	8		10	7
Found.....	4.17	8.03	3.89	11.83	8.49

Results of analyses of commercial fertilizers

Laboratory number. A	Manufacturer	Trade Name
*961	Tuscarora Fertilizer Co., Chicago.....	Wolverine Special.....
841	Wuichet Fertilizer Co., Dayton, Ohio.....	Onion and Truck Fertilizer.....
*784	Wuichet Fertilizer Co., Dayton, Ohio.....	Onion and Truck Fertilizer.....

*Manufacturers' sample.

for 1905, expressed in parts in a hundred.—CONCLUDED.

	Nitrogen	Phosphoric acid			Potash soluble in water, estimated as K ₂ O
		Available	Insoluble	Total	
Claimed.....	.82	8		10	4
Found.....	.90	8.02	.88	9.45	4.14
Claimed.....	1.50	8		10	8
Found.....	1.34	12.00	3.25	15.25	4.84
Claimed.....	1.50	8		10	8
Found.....	1.66	11.43	2.26	13.83	9.13

BULLETIN 233

DECEMBER, 1905

MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

DEPARTMENT OF ENTOMOLOGY

INSECTS OF THE GARDEN

BY

RUFUS H. PETTIT

AGRICULTURAL COLLEGE, MICHIGAN
1905

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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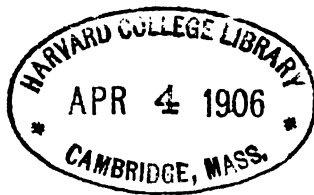
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INSECTS OF THE GARDEN.

INTRODUCTION.

The present bulletin is the second of a series dealing with the insects affecting different classes of crops. It deals with the insects now affecting garden and truck crops in Michigan and some which are sure to be found in the State sooner or later. Only insects of importance or of interest have been included. Most rarities have been omitted in order to prevent confusion.

Many facts have been drawn from the writings of others, notably from those of the Department of Agriculture at Washington; from the bulletins of Professor Slingerland of Cornell University; from the Canadian reports; from the bulletins of many of our State experiment stations.

It must be borne in mind that insects affecting truck crops and those of the garden as well, very often work also in field crops and in grains. It is not the purpose of the writer to enter upon the subject of field and grain crops in the present bulletin, that phase of the subject being reserved for the future. Methods of use in small areas are often useless in large fields, thus in the case of sweet-corn it often happens that methods which would not pay in large fields, will be of good service in smaller areas where the cultivation is more intensive and the price received for the output will warrant more outlay in case of an emergency.

The illustrations are from various sources. Credit is given in each case where the source is known.

On pages 65 to 67 are given the methods of preparing the insecticides recommended in this bulletin.

The entomologist is always glad to receive specimens of insects or of their work, and in return to name them when possible and to give advice as to control. Send specimens, if possible, in tight tin boxes with few if any holes.

The first bulletin of this series dealing with fruit insects is number 24, special. This is to be had on application as long as the supply lasts. It is intended that other bulletins of like nature will be issued on field crops, pests of forest, shade and ornamental trees, etc., if there seems to be a demand for them, and these if preserved, with the rest of the series may prove useful for reference.

Always send specimens of insects to the

Entomologist of the Experiment Station,

Agricultural College, Mich.

INSECTS INJURIOUS TO ASPARAGUS.

AFFECTING THE TOPS.

The Asparagus-beetle (*Crioceris asparagi*).

At some time near the middle of the nineteenth century, there came over from Europe, a beetle which has gradually extended its range until at present it is pretty well known all over the United States and Canada. It reached Michigan about 1896, appearing in Berrien County. The insect under discussion is a dainty, neat little creature, brightly colored and polished. It is about one-fourth of an inch in length, the wing-covers being reddish-yellow and cream colored, marked with black; and the thorax reddish-yellow with black dots. The larvae are slimy olive-grey with blackish head and legs. The elongate, black eggs, about one-tenth of an inch in length, are set on end on the young shoots of asparagus. They hatch in about eight days, and the larvae excavate pits which become discolored and prevent the sale of the stalks. In about two weeks, the larvae become full-grown and go into the ground to pupate, emerging as adults after about eight days, the entire time required for the completion of the life cycle being about a month. This allows ample time for several generations each year. The winter is passed in the adult condition, under rubbish, loose bark, etc.

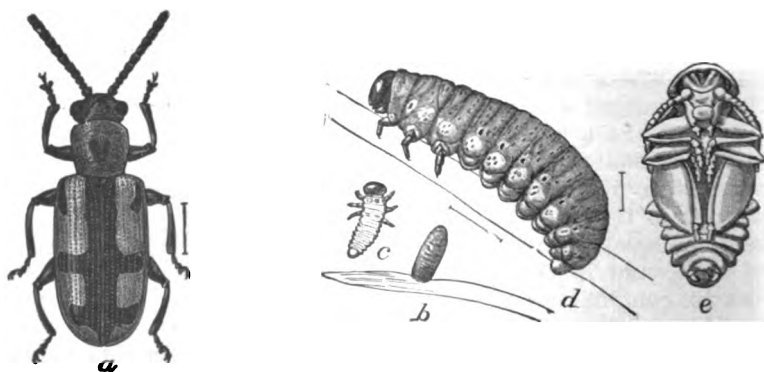


Fig. 1.—Asparagus Beetle; enlarged. a, adult beetle; d, larva; c, young larva; b, egg; e, pupa. (Chittenden, year book Dept. Agr. for 1896.)

REMEDIES.

Fields from which the shoots are being cut, should never be sprayed because of the danger to life. Leave some young shoots for the beetles to lay their eggs upon, and cut and burn these shoots before they are a week old, to destroy the eggs. If patches of such trap plants be systematically left over the field and carefully cut and burned just before the eggs hatch early in the season, there is usually little trouble

as the season advances. As soon as the cutting season is over, the whole field should be sprayed or dusted with paris-green and lime. All seedlings and feathery plants should also be included in this general spraying. Late in the fall burn all rubbish on and about the field to kill the hibernating adults. Dry-slaked lime will kill the larvae if dusted on them, as will also Pyrethrum or kerosene-emulsion if applied, but Pyrethrum is expensive and the emulsion is apt to scent the shoots.

INSECTS AFFECTING THE BEAN.

INSECTS FEEDING ON THE FOLIAGE.

Pale Striped Flea-beetle (see Insects Affecting Beets).

Cut-worms (see Insects Affecting Sweet-corn).

Blister-beetles (see Insects Affecting Beets).

INSECTS AFFECTING THE SEEDS.

Bean-weevil (*Bruchus obtectus*).

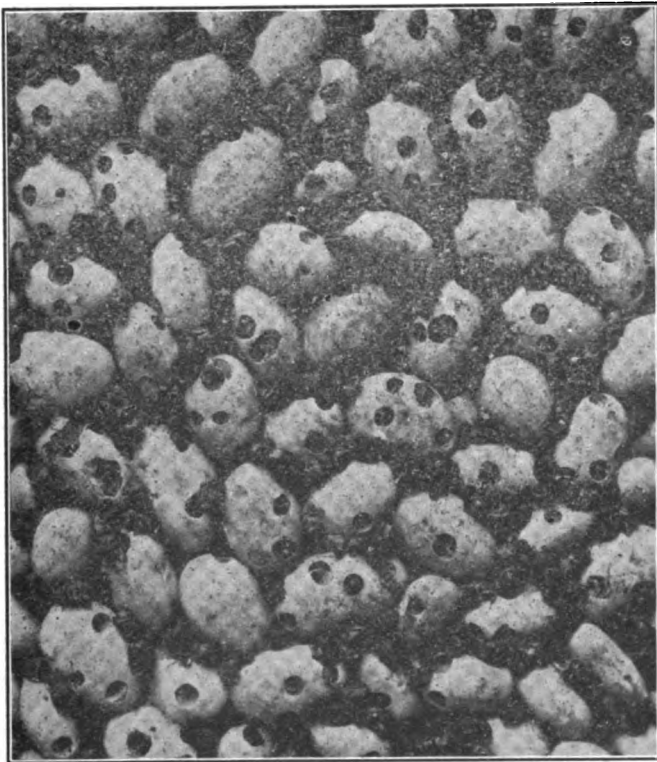


Fig. 2.—Beans infested with bean-weevil, slightly enlarged. Original.

The beetle of buggy beans, belongs, of course, with the insects affecting dried seeds and grains in a bulletin to come later, but as it also works in green beans, a short account is included here.

This pest which destroys such quantities of seed beans is only about one-eighth of an inch in length. It is brownish-grey in color with a greenish tinge. It carries its head bent at right angles to the body, and the wing-covers are somewhat shorter than the abdomen, lending to the beetle the appearance of wearing an outgrown coat. There are several generations each year, the eggs of the first generation being laid either on the outside of the pod or in slits cut with the jaws. The larvae immediately enter the pod and afterward the beans, sometimes several working in the same seed. When the beans are harvested and threshed, the beetles continue to work in the dried beans, and sometimes in dried peas, rearing several generations in the course of a year.

When the beetles are numerous their work results in the more or less complete destruction of the beans. Infested beans are not suitable for seed, as the beetles that come from them attack the green beans, furthermore such beans produce inferior plants when they do grow.

REMEDIES.

Fumigation of the seed with carbon bisulphide is the only reliable and efficient measure for this pest.

INSECTS AFFECTING THE BEET.

INSECTS WORKING ON THE ROOTS.

The Clover-root Mealy-bug (*Dactylopius trifolii*).

On one occasion, the writer found numbers of mealy-bugs working on the roots of small sugar-beets. Their presence was indicated by the unhealthy, yellow appearance of the beets affected, some of which died, but the trouble was of short duration and did not affect more than a single field. The field in question was preceded by clover which had been infested. For a description of this insect and its work see Bulletin 200 of this station.

White-grubs (see Insects Affecting Sweet-corn).

Wire-worms (see Insects Affecting Sweet-corn).

INSECTS WORKING ON THE FOLIAGE.

Plant-bugs (*Lygus pratensis*) et al.

A long list of plant-bugs have been seen to work on the beet, notably on the sugar-beet, but our worst enemy of this type is the common tarnished plant-bug. This bug is flattened in form, and a little less than one-fourth of an inch long, metallic brown, variably marked with yellow and black. The whole resulting in a surface resembling tarnished brass, hence the name. The young are greenish in color with five black dots on the back. There are several generations each year, the insect work-

ing from early spring until fall. The adults winter in rubbish and stubble, under fences, out-houses, etc.

REMEDIES.

Poisons like the arsenites are of no value against insects of this class owing to the fact that the bugs suck the sap from beneath the surface, thus escaping any coating that may be placed thereon. It is necessary to use something that kills by contact, and to make such a spray effective, each bug must be hit to be killed. Use kerosene-emulsion diluted about ten times when the bugs are young and make it strong as the plants will stand when the plants get older and more resistant. It may be preferable to use the Pyrethro-whale-oil kerosene-emulsion in some cases.

Clean culture.—As the majority of the adults pass the winter in rubbish, along fences, etc., it follows that clean culture and the late burning of such material will get rid of them. Burn as late as possible in order to catch these and many other pests after they have settled for the winter.

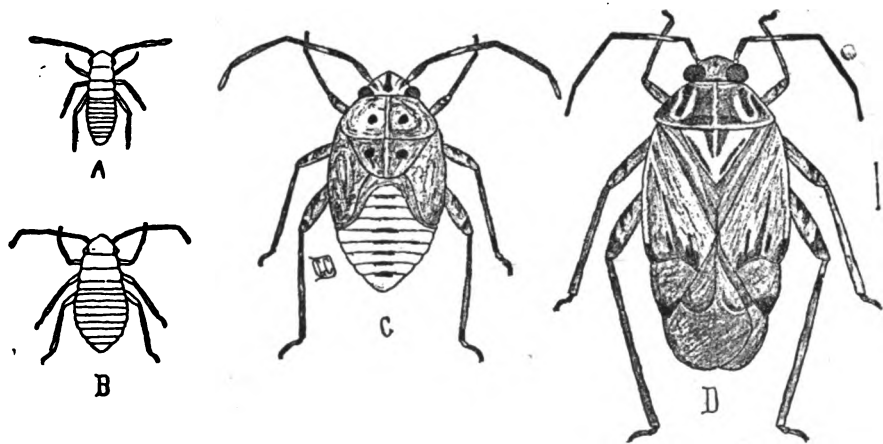


Fig. 3.—Tarnished plant-bug, showing various stages of growth, enlarged, (after G. C. Davis.)

Large-eyed Ground-bug (*Geocoris bullata*).

A short dumpy bug, of unprepossessing appearance, is often found in sugar-beet fields, its natural food being purslane, pig-weed, smart-weeds and others. In common with many other weed insects, it appreciates the beet for a change. The writer has never heard of serious injury by this bug. It is amenable to a spray of kerosene-emulsion.

Plant-lice (*Aphididae*).

Several species of plant-lice or aphids are to be found on the beet. In Michigan we have at least one species and probably more. Most of the insects of this sort feed also on weeds or on some other garden crop. The occurrence of plant-lice on beets has, thus far, been local and no very serious cases have been brought to the notice of the writer, except in the case of mother beets, or seed beets of the sugar producing type.

In such cases the lice have been readily killed by a spray of to-bak-ine, a tobacco extract containing about fifty per cent of nicotine. This has been put on at the rate of five teaspoonfulls to two gallons of water, and applied with a bucket spray. One application has been known to do a clean job with no injury to the plants. Doubtless some of the kerosene-emulsions will also kill them satisfactorily.

Leaf-hoppers (*Jassidae*).

A number of species of leaf-hoppers feed on the leaves of the beet.* All are small, rather slender, and all jump on the slightest provocation. They suck the sap from beneath the surface of the leaves, leaving a small dead spot to mark each puncture. This would ordinarily amount to little, but when the insects come in swarms, as is often the case, the aggregate amounts to a good deal. It is not possible to control these pests by spraying with poisons, as they pierce beneath the surface for their food supply. The contact insecticides will kill a certain proportion of them, but no spray yet devised is satisfactory unless used when the pests are small. They pass the winter in rubbish, under leaves, etc., therefore collect and burn all rubbish after cold weather sets in.

GRASSHOPPERS.

When, from time to time, grasshoppers attack the beets, they should be killed by poisoned baits, provided of course, that such baits may be used without danger to stock or poultry. Criddle mixture, a mixture of arsenic, salt and horse-manure, is highly recommended by several who have tried it. Bran and arsenic, or paris-green and bran, has the disadvantage that it is readily eaten by birds and poultry. For a further discussion of grasshoppers see Insects of Sweet-corn.

Beet Web-worm (*Loxostege sticticalis*).

From time to time we meet the beet web-worm, an insect that, on several occasions, has been very severe in its attacks. The eggs of the web-worm are laid on the leaves, and the larvae that come from them attack the foliage, either spinning small webs among the young and tender shoots at the center of the plant, or else feeding on the underside of the larger leaves, either protected by a small web of silk or else exposed, with no protection whatever. The caterpillars are pale yellowish-green, or reddish-yellow in color dotted with small black points, each of which bears a hair. They are about three-fourths of an inch in length. The head is yellowish-brown marked with brown spots; the prothoracic shield is somewhat lighter in color. The backs of the first two segments each bear four black dots; segments three to eight each bear six black dots, arranged in two triangles. Segment nine has one larger median spot with two smaller lateral ones and segment ten has the anal shield, dirty yellow in color, marked with brown spots. The under side is marked somewhat similarly with dirty spots, each spot being bordered indistinctly with pale. The legs are pale with darker markings.

The pupa of this moth is buried in the soil. The larva spins a slender

*See Forbes and Hart, Bul. 60, University of Illinois, Experiment Station.

silken tube about three-quarters of an inch long, and in this tube the pupal stage is passed. In the early broods the pupal stage is of short duration, but the members of the last brood remain in the tubes over winter. There are several generations each year.

REMEDIES.

Spray with paris-green on the first appearance of the larvae, using lime as indicated in the directions for preparing insecticides. Use one pound of the poison to one hundred and seventy-five gallons of water. Plow the field after harvesting the beets, so as to expose the pupae to the birds. In spraying, use a nozzle set at right angles to a short extension, so that it will be easy to spray upward from beneath.

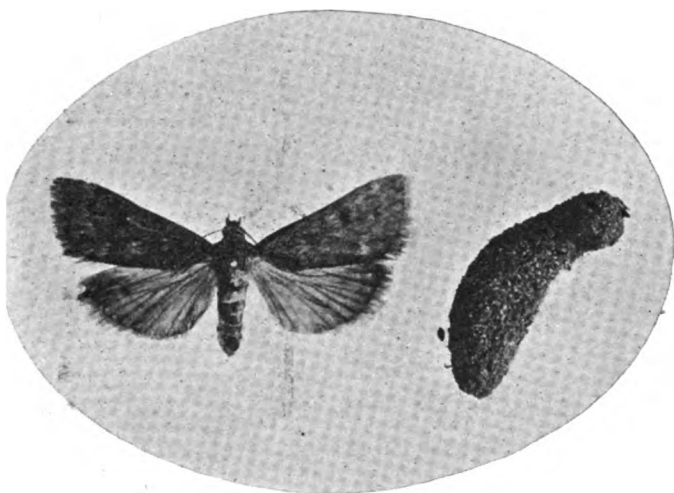


Fig. 4.—Beet web-worm, adult, and silken tube in which pupal stage is passed, enlarged. Original

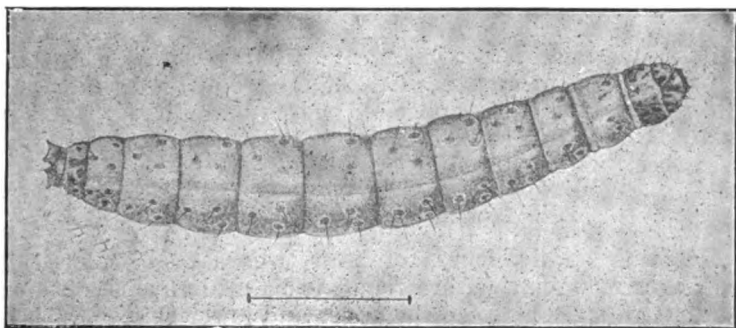


Fig. 5.—Beet web-worm, enlarged. (Author's illustration.)

Zebra Caterpillar (*Mamestra picta*).

A very general feeder is the zebra caterpillar; cabbage, cauliflower and other plants of that type seem most to its liking, but the beet does

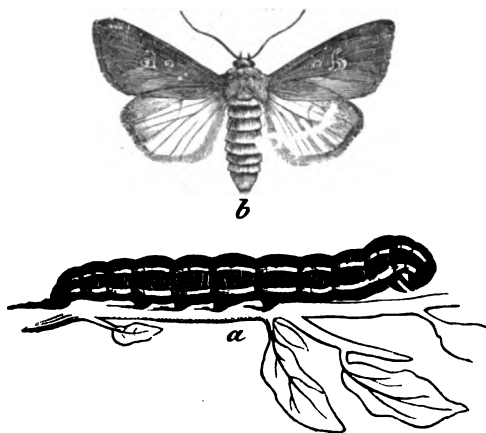


Fig. 6.—Zebra caterpillar. (After Riley, Second Rep. Insects of Mo.)

not escape. The moth, shown in Fig. 6, is dark brown in color, except the hind-wings, which are pale yellowish. The eggs are laid in clusters on the foliage and the young larvae, at first hairy but later naked, soon scatter over quite wide areas. When full grown, the larvae are yellow in color with three broad, black, longitudinal stripes, those on the sides being cut up by fine white lines. The pupal stage is passed underground. Two generations are brought forth each year, the most destructive one in June and July.

Cut-worms.

A goodly number of cut-worms feed on the beet. As yet, they have been but little studied in Michigan but all of them respond to the same treatment. See Insects affecting Sweet-corn.

REMEDIES.

Spray with paris-green and lime, using one pound to one hundred and seventy-five gallons of water. If the insect appears on cabbages or on some other vegetable where poison would not be permissible use Pyrethrum or one of the kerosene-emulsions.

Cabbage Plusia (see Insects Affecting the Cabbage).

Woolly-bear (*Spilosoma virginica*).

Oftentimes, one finds large, hairy caterpillars among the beets. They are light yellow in color and they eat the foliage of the beets voraciously. Such caterpillars turn into good sized moths or millers. Hand picking will usually be found to suffice for them, but when necessary, they may be kept in check with one of the arsenites.

Beet Leaf-miner (*Pegomya vicina*).

One often sees on the leaves of beets, raised or discolored blisters which on closer examination, are found to be made by insects that have tunnelled out passages between the upper and lower skins. Such blisters or tunnels are called mines, and the insects that make them are called leaf-miners. On the beet we have such leaf-miners, the larvae or maggots of which make irregular blotch mines of small size. When full-grown, the larvae usually desert the leaves and pass through the pupal stage under fallen leaves or in the soil. The adult fly, or parent form, looks very much like a house-fly except in size, being about half the size

of the house-fly. There are a number of generations each year, the last generation passing the winter in the pupal stage.

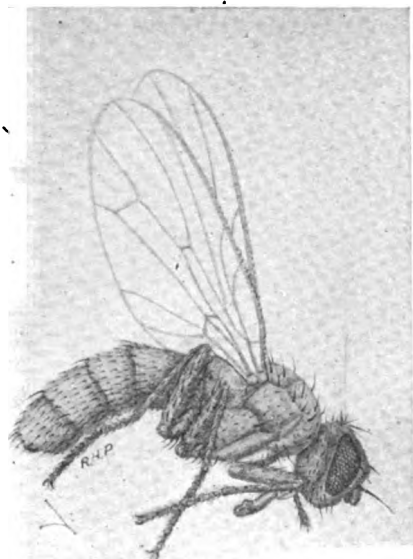


Fig. 7.—Adult of beet leaf-miner, enlarged. (Author's illustration.)



Fig. 8.—Beet leaf-miners. Mine in leaf. Original.

REMEDIES.

The fact that the winter is passed under fallen leaves in the field, suggests the destruction of such rubbish by plowing immediately after harvesting the beets. No benefit seems to have resulted from sprays, thus far. Fortunately the damage is usually restricted to spoiling the tops for greens.

Blister-beetles.

- Old-fashioned Potato-beetle (*Epicauta vittata*).
- Ash-grey Blister-beetle (*Macrobasis unicolor*).
- Black Blister-beetle (*Epicauta pennsylvanica*).
- Margined Blister-beetle (*Epicauta cinerea*).

' We have in Michigan four different kinds of blister-beetles, viz.: the ash-grey, the margined, the black, and the striped or old-fashioned potato-beetle. All of these blister-beetles feed on the beet and on various other plants. They seem to prefer members of the clover family; sweet-clover, vetches, etc., which they attack during the latter half of July and August. The black species is found on golden-rod in great numbers,

late in the season. The appearance of a blister-beetle is shown in fig. 9, long, slender, and with graceful legs and form, a little more than half an inch in length. These four species differ markedly in color. The one figured, is known as the old-fashioned potato-beetle because of its well-known love for that plant. It is striped, yellow and black, with black legs. The black and grey species look very much like the striped one except for the color, and the margined beetle is dead black in color with the margins of the wing-covers grey. They all eat the foliage of beets when adult and often commit serious depredations. One word in extenuation before pronouncing sentence of death on these small

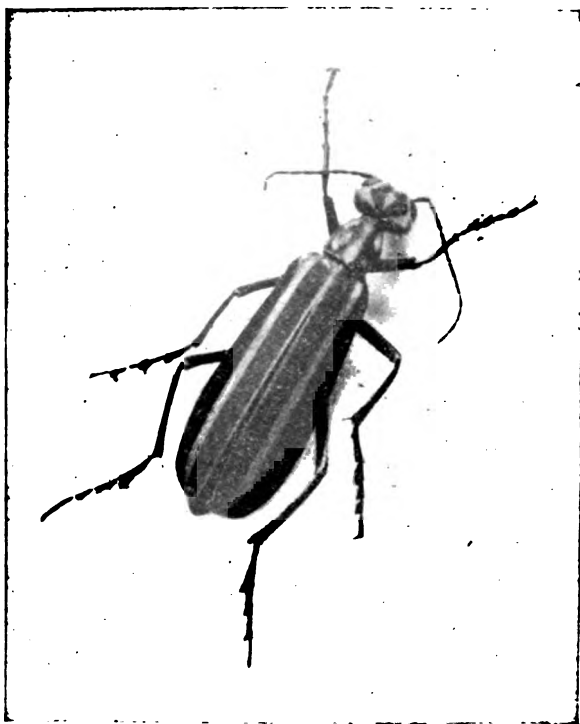


Fig. 9.—Old-fashioned potato beetle, enlarged. (Author's illustration.)

malefactors. Their larval stages, in all our common species except the steel-blue one, are passed in devouring the eggs of grasshoppers. In fact, the young blister-beetles of this group are not known to feed on anything else. The fact that the eggs of grasshoppers are laid in pods covered with water-tight shells, and containing from twenty to thirty eggs, makes it possible for the beetles to do a great deal of damage to the contents of the pods by devouring part of the eggs. If all are not eaten, fermentation and the consequent loss of the rest of the batch are sure to follow. From this we see that it is possible for the beetle to attain

its majority only at the expense of many grasshopper eggs. The beetles then are our friends if they occur in anything like moderation but lest we be overrun by these well meaning but hungry allies, it is often desirable to get rid of them.

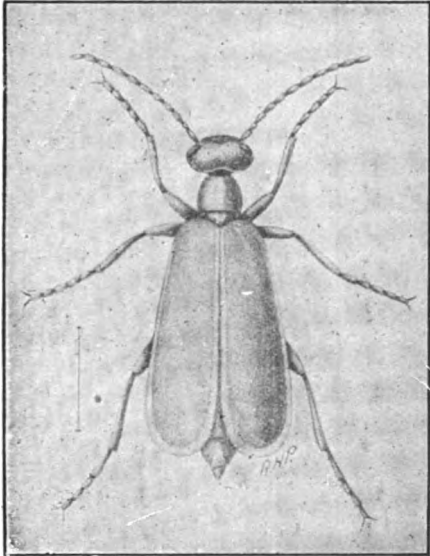


Fig. 10.—Margined blister-beetle, enlarged.
(Author's illustration.)

which they are capable of taking long leaps after the manner of the common flea. They all belong to the family of leaf-beetles and feed on vegetation. The one in question, the pale, striped flea-beetle is very small, measuring about one-eighth of an inch in length, and is yellowish-brown in color. Down each wing-cover extends a yellow stripe. The prothorax is also yellow, the head brownish-red, the legs yellowish-red and the under side of the body black.

While pre-eminently a pest of the sugar-beet, in Michigan, this beetle makes its presence felt very forcibly on the garden beet, as well as on corn, beans and potato. It dearly loves sorrel (ordinary red or horse-sorrel), pig-weed or lamb's quarter, rag-weed and a great variety of cultivated plants and weeds.

The slender, thread-like larvae of this beetle are said by Chittenden* to feed on the roots of corn, lamb's quarter, and probably also on the roots of Jamestown weed. They are white in color with a moderate number of hairs. They are pests of dry seasons, rarely doing serious injury during wet weather. The worst damage is done while the beets are small, usually when they have about two leaves. Under such conditions, the beetles sometimes spoil quite large areas, usually in sandy regions. When the beets are larger, the insects eat out the soft tissue

REMEDIES.

Paris-green applied as a spray will kill them, although it works slowly. Before the days of paris-green, it was the custom of our forefathers, to drive the beetles, when they came in droves, by brushing them with the branches of trees, into windrows of dry straw, and then to burn them up. Dry-slaked lime, and paris-green, one part of the latter to fifty parts of lime, dusted through coarse cloth or burlaps, will kill some and drive many away.

The Pale Striped Flea-beetle (*Systema blanda*)

Flea-beetles, as the name implies, have strongly developed, jumping hind-legs, by means of

* Bul. 23, N. S. Bureau of Ent. Depart. of Agr.

in patches, either on the upper or under surfaces of the leaves, after which the remainders of the patches dry up and fall out leaving unsightly holes which increase in size as the leaf expands.

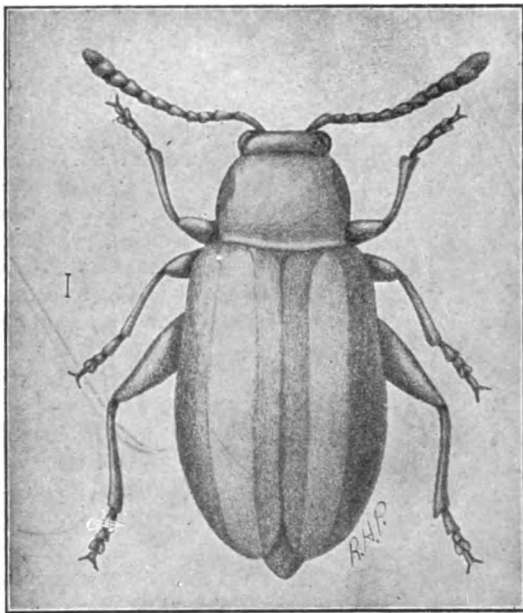


Fig. 11.—Pale, striped flea-beetle, enlarged. (Author's illustration.)

fore applying. Clean culture and the destruction of all rag-weed, pig-weed, etc., in the fence corners, will tend to starve out this pest in common with many others.

The Triangle Flea-beetle (*Disonycha triangularis*),

The triangle flea-beetle is so named because of the three dark round spots placed in a triangular position on the orange prothorax. In size, this beetle varies from about three-sixteenths to one-fourth of an inch. It is blue-black in color with the exception of the orange prothorax before mentioned. It has the strong, jumping hind legs of its family. It works on the beet primarily, and is controlled by the same measures that govern the pale, striped flea-beetle. In fact it is usually found in company with the latter insect.

REMEDIES.

Spray with paris-green and bordeaux, using one pound of the poison to 175 gallons of the bordeaux, made in the ordinary way. The bordeaux is useful against this and many other flea-beetles, acting as a repellant rather than as a poison.

Dusting with dry-slaked lime and paris-green should prove very effective as all flea-beetles dislike lime. Use one part of the poison to one hundred of the lime and mix very thoroughly be-

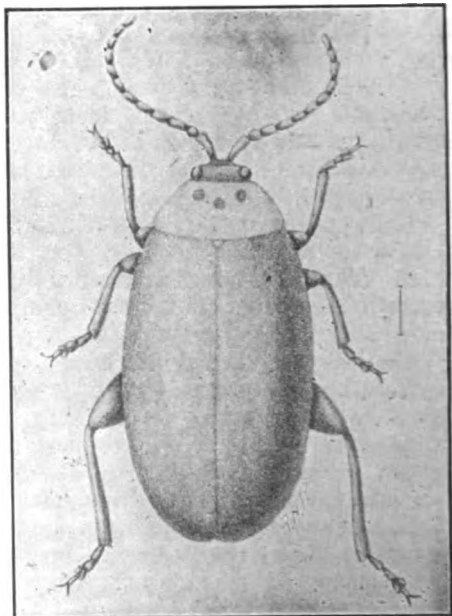


Fig. 12.—Triangle Flea-beetle, enlarged. (Author's illustration.)

Cucumber-beetle (*Diabrotica vittata*).

The cucumber-beetle occasionally feeds on the sugar-beet. It is controlled by the same methods as those used against the pale, striped flea-beetle. For a description of this insect see Insects Affecting the Cucumber.

Potato Flea-beetle.

Occasionally, this little pest attacks the beet foliage. For remedies, see Insects affecting the Potato.

INSECTS INJURIOUS TO CABBAGE.

AFFECTING THE ROOTS.

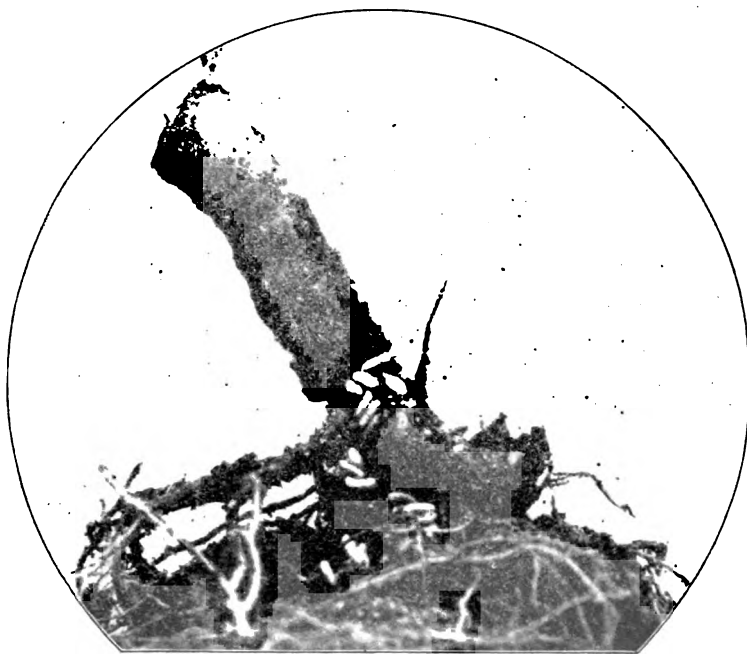
Cabbage Root-maggot (*Pegomya brassicae*).

Fig. 13.—Cabbage maggot. Maggot in root, enlarged, after Prof. M. V. Slingerland.

Perhaps the most unsatisfactory insects of the garden are the root-maggots, and the one on cabbage is no exception to the general rule. The eggs of this fly are laid in crevices in the soil near the root. The fly resembles, more or less, the house-fly except in point of size, being about one-fifth of an inch long. The maggot that hatches from the fly, bores into the root of the young cabbage or cauliflower plant, and

scrapes its way all through the tissue, forming tunnels or channels, and causing the root to rot. Sometimes several maggots attack a single root. In about three or four weeks, the maggot becomes full grown, then being about one-third of an inch in length. It then changes to a pupa, the larval skin becoming papery and forming a shell, inside of which the change occurs. After a short time, the adult fly cracks open the shell and emerges, and a new batch of eggs is laid. The worst injury is done to the young plants, before they attain much size. There are several generations each year. The winter is said to be passed for the most part, at least, in the pupal condition, although it is likely that some of the adult flies hibernate in sheltered places. For a minutely detailed account of this insect consult Bul. 78, of the Cornell Experiment Station by Professor M. V. Slingerland.

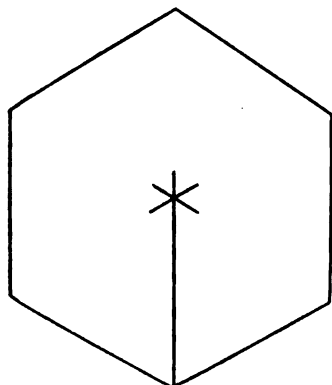


Fig. 14.—Card of tarred building-paper ready to place on stem of cabbage. After Slingerland

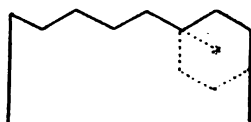


Fig. 16.—Diagram showing method of cutting. After Slingerland.

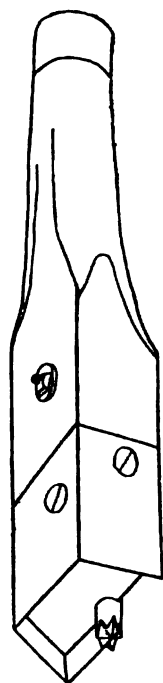


Fig. 15.—Tool for cutting cards of tarred building paper. After Slingerland.

REMEDIES.

Control of the cabbage root-maggot is best obtained by preventing the laying of the eggs, by means of a repellant. Professor Slingerland in his exhaustive experiments secured the best results by placing a small hexagonal piece of tarred building-paper, about two and one-half inches in diameter, about each plant shortly after setting time. Each piece or pad had a slit running to the center and a star-shaped cut at that point. It was pressed close to the ground and put on squarely so that it afforded almost complete protection to the crown of the plant, thus preventing the female from depositing her eggs. These pads were cut

out of rolls of building-paper by a special hand tool and hammer. It really costs less than one would expect to treat an entire field, and succeeds in restricting the invasion of the maggots to a large extent.

We have succeeded in restricting their ravages materially by placing about a tablespoonful of tobacco dust about the stem of each plant, and this is common practice among some of our Michigan market gardeners, although the paper pads probably are more effective.

Professor Cook, formerly of this station, and afterward Professor Slingerland obtained quite satisfactory results with an emulsion of crude carbolic acid. Make it according to the formula on page 66, and dilute about thirty times with water. This should be applied about the base of the plant the day after setting and repeated every ten days until about May 25th, using about one-half teacupful to each plant and pouring it about the root with a sprinkler.

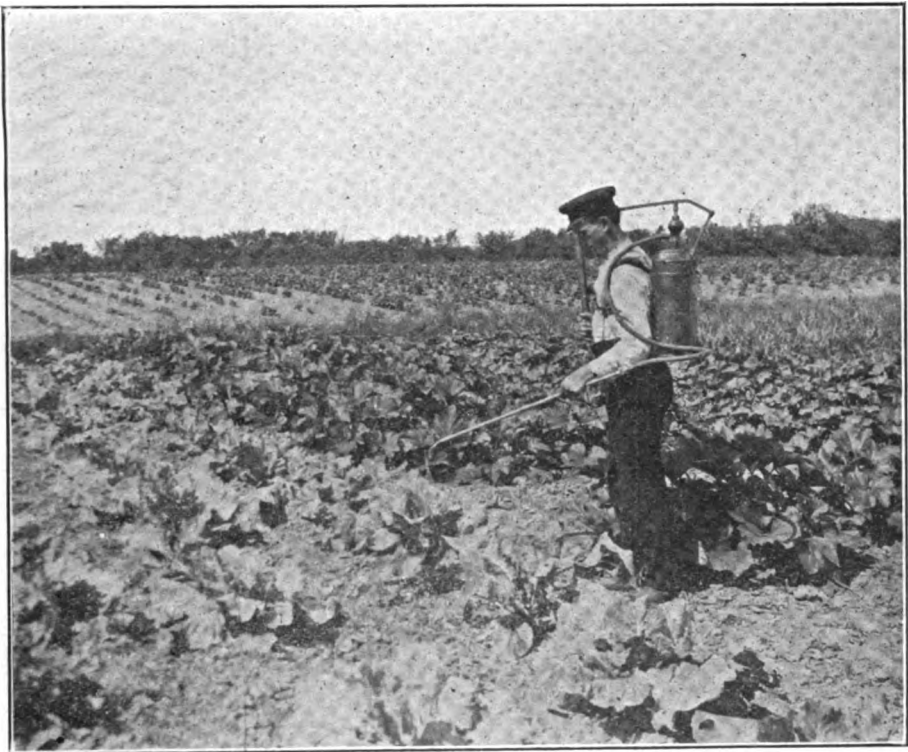


Fig. 17.—Spraying cabbage, with knapsack pump and short extension. Original.

INSECTS AFFECTING THE LEAVES.

The Cabbage Aphid (*Aphis brassicae*).

From mid-summer until fall, cabbages are subject to attack by plant-lice. Of course the lice are present earlier in the season but in such small numbers that they escape detection. Both winged and wingless

forms occur, all of them being covered with a coat of fine waxy powder, very much like the bloom on the leaves of the cabbage on which they rest. This waxy bloom, no doubt serves as a protection by helping to conceal the insect, but when we come to spray we find that it helps very effectually to repel the liquid. Lying, as they do, in closely packed colonies, which sometimes cover almost the entire underside of a leaf, one would expect to kill them with ease. One finds, however, on trying to do so, that most spray mixtures slide from them like water from a duck's back. Furthermore it is very difficult to reach them when under the foliage. In order to overcome this last difficulty, we have used a short extension, about three and one-half feet long, with a Vermorel nozzle set at right angles to the extension. This makes it easy to reach the underside of the leaves and by simply turning the extension in the hand, one can spray downward on the head of the cabbage.

The best sprays for the lice that we have been able to find are tak-a-nap soap, used at the rate of one pound to four gallons of water, and Pyrethro-kerosene-emulsion made with whale-oil soap. This is diluted ten times. Both of these sprays killed apparently all the lice that were hit. The difficulty of hitting all the lice with a spray can be appreciated only by those who have made the attempt.

Cabbage-worms (*Pieris rapae*, *Pontia protodice*, *Pieris oleraceae*).

Three species of cabbage-worms or cabbage-butterflies grace the State of Michigan. They are, the Northern native white or pure white butterfly (*P. oleraceae*), the southern native white or checkered white (*P. protodice*), and the imported white or common cabbage-butterfly (*P. rapae*). The larvae or caterpillars of each of these butterflies feed on cabbage, rape, cauliflower and all of their near allies, with such enthusiasm that it will not be necessary to say more on that score. Before the advent of the now commonest species shown in fig. 18, the pure white cabbage butterfly* fed in peace in the northern United States, inflicting comparatively little damage. The southern cabbage-butterfly, with its checkered, black and white wings did likewise in the more southerly regions, the two species overlapping in a region that included our State. The accidental importation of the European cabbage-butterfly changed all this, for the native species could not compete with their more vigorous cousins; gradually they faded away before the advance of the aliens, until now they have almost disappeared from certain parts of the country.

When full grown, the larvae transform to naked pupae, remaining attached to the underside of the food-plants or on some nearby object, later changing to the butterfly stage.

The writer has seen all three species working together in large numbers in one field, in Alger County. The larvae differ somewhat, but all are readily recognizable as cabbage-worms.

REMEDIES.

From the nature of the case, it is not expedient to use poison on the cabbage, certainly not after the plants have shown a tendency to head.

* There is a spring form in which the veins on the under side of the wings are marked with gray scales.

Neither rape nor cauliflower suggest themselves as fit subjects for the arsenites. Hot water has been used extensively for killing the worms. The water is poured onto the plants through a sprinkler, held at just the right distance from the plant, the distance to be determined by experiment. It is possible to kill the worms without injuring the plants, when once the proper distance has been determined, depending upon the size of the holes in the sprinkler and the temperature of the water. However, the sprinkler method becomes very burdensome when used on a large scale. The use of Pyrethrum or of Pyrethro-kerosene emulsion is even more effectual and involves less labor. Pyrethrum or Buhach if fresh and pure can be made to do all the work with very little labor. Apply with an atomizer, using one-half ounce to a gallon of water. We have used this with very gratifying results apparently killing all the worms that were hit. It is but fair to state, however, that the Pyrethrum used has been of the very highest quality, being that grown in California and kept in tightly sealed tin cans. This costs about 75 cents per pound, making the spray $2\frac{1}{2}$ cents per gallon. A gallon will spray a large number of plants, so that after all it is not expensive.

Whale-oil Pyrethro-kerosene-emulsion, or emulsion to which Pyrethrum has been added (see directions for making insecticides) works very nicely, in fact nearly as well as the Pyrethrum alone and it costs only a little over a cent per gallon, if the materials are purchased in fairly large quantities. In fact if one can not procure the best of Pyrethrum to begin with, it is likely that the emulsion referred to will prove more uniformly successful. Dilute the emulsion about eight times with water. When diluted ten times, it failed to kill a few of the worms and when diluted only six times, it burned the foliage slightly.

The Cabbage-looper (*Plusia brassicae*).

Less conspicuous in its work, but nevertheless of much importance, is the cabbage-looper, so named because of the looping or measuring gait of the larva. This pale-green, almost translucent larva reaches a size slightly larger than the common "cabbage-worm." It is rather obscurely

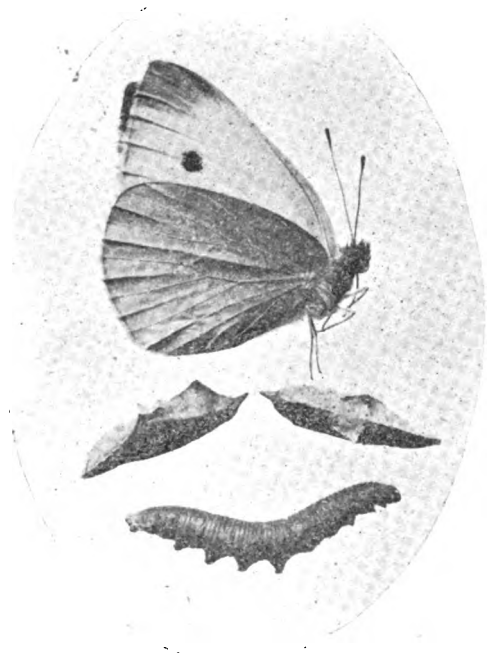


Fig. 18.—Imported cabbage-worm larva pupae and adult, slightly enlarged. Original.

striped longitudinally. The larva walks with a looping gait owing to the fact that there are no legs for the middle region of the body.

When full-grown, the larva spins a white, silken cocoon, sometimes under a leaf blade, often on some other object near at hand. After a time, the adult makes its way out of the cocoon. It is a winged moth or miller which spreads about one and one-half inches from tip to tip

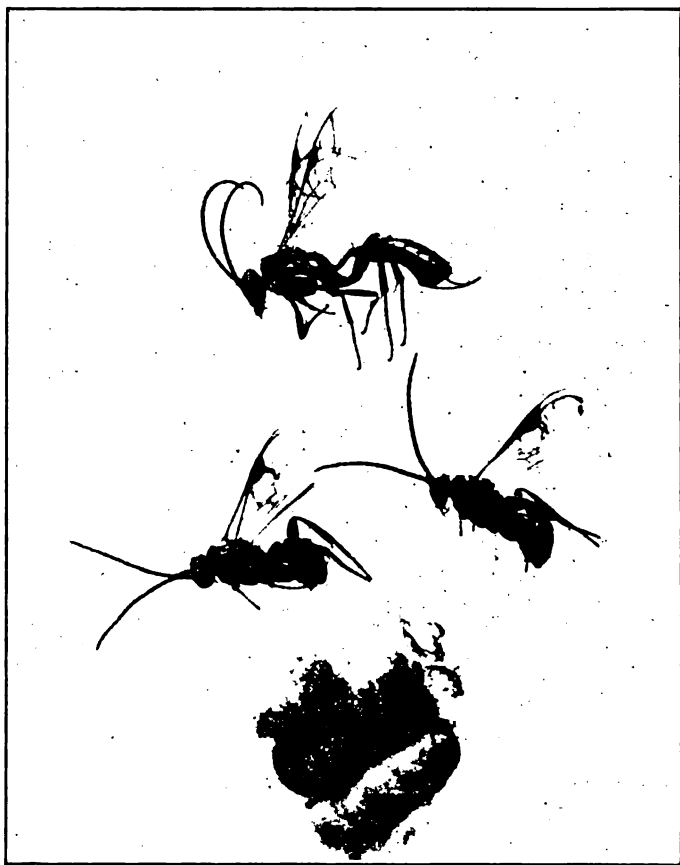


Fig. 19.—Parasites of cabbage-worm, with cocoons, enlarged. Original

of the wings. It is brownish-grey in color, the front-wings being more or less transversely mottled, each front-wing bearing a small silver-white, well-defined spot, the hind-wings being lighter in color and without mottlings.

REMEDIES.

The same remedies that apply to the common cabbage-worm, will serve for the looper.

Diamond-back Moth (*Plutella maculicollis*).

A very small green larva or "worm" often works on the leaves of plants of the cabbage family, a worm exceedingly active when disturbed, one that will wriggle all over the hand in its efforts to escape when captured. Oft-times it lets itself down out of harm's way by spinning a silken thread from which it hangs suspended. The length of this little pest is about one-third of an inch.

When numerous these larvae eat holes in the leaves of the plants to such an extent as to disfigure the plants very appreciably. They eat the soft tissue from one surface of the leaf, leaving the exposed remnant to dry and fall out. When full grown, each larva constructs a beautiful little cocoon of white silk. Lace like in texture, it consists of gauzy open work, and inside may be seen the pupa, awaiting the time when the final transformation to the adult stage is to be made.

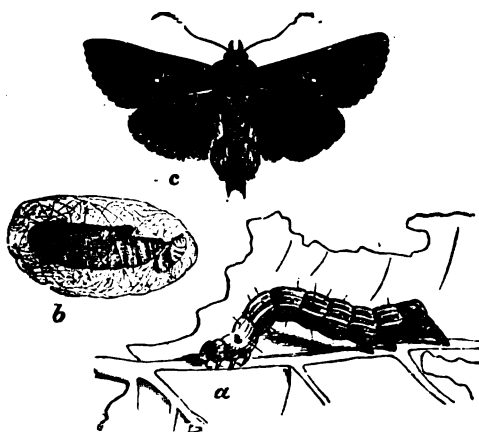


Fig. 20.—Cabbage-looper, after J. B. Smith, State Exp. Station of New Jersey.

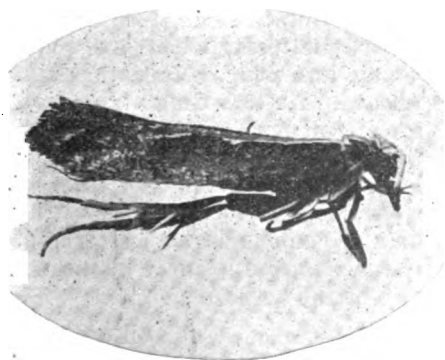


Fig. 21.—Diamond-back moth, enlarged Original.

folded roof-wise over the back, with an abrupt elevation at the posterior end. There are several generations each year. The same remedies that are used against the cabbage-worms will keep this little moth in subjection.

Cabbage Flea-beetle (*Phyllotreta vittata*).

Like all of the flea-beetles, the cabbage flea-beetle is small and inconspicuous, though very active, jumping long distances when disturbed. It is less than one-tenth of an inch in length, black in color, with a well-

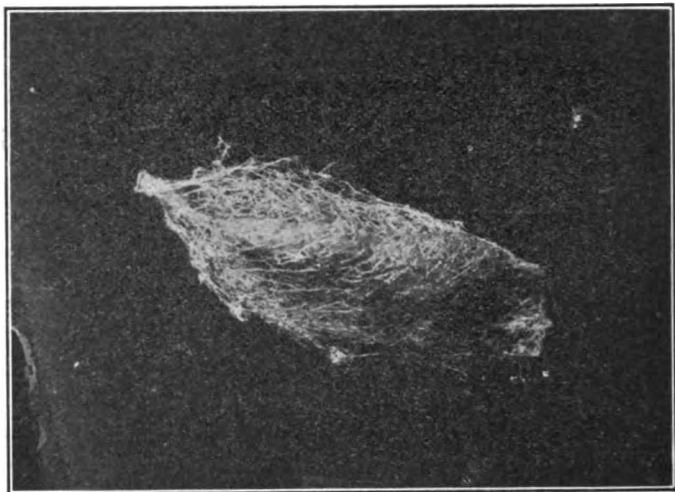


Fig. 22.—Cocoon of diamond-back moth, enlarged. Original.

marked yellowish stripe on each wing-cover. The larva is said to be long and slender, and to mine in the leaves of young cabbage plants.

REMEDIES.

The worst damage is inflicted by this little pest, when the plants are young and long before the heads are formed. At this time a spray of paris-green and bordeaux will serve to check them, the bordeaux acting as a repellant. It is probable that tobacco dust would also serve the purpose, if dusted on the young plants. After the heads commence to appear it is unsafe to use any of the arsenites.

Cabbage Curculio (*Ceuthorrhynchus rapae*).



Fig. 23.—Parasite of diamond-back moth, enlarged. Original.

This beetle belongs to the curculios and is about one-eighth of an inch long, broadly oval in form, the color being black modified by fine light grey hairs. The species is carefully and fully described by Mr. F. H.

Chittenden in the bulletin cited. The damage brought about by this beetle is said to be largely due to its spreading the cabbage rot, a disease that causes considerable loss annually.



Fig. 24.—Cabbage flea-beetle, enlarged. (From Walsh and Riley, Amer. Ent., vol. I, p. 158.)

REMEDIES.

The beetle is said to prefer wild hedge mustard and pepper-grass to cultivated plants. It is recommended that all such plants be pulled up and burned about the middle of June, after the eggs are laid. Arsenical poisoning is also recommended while the plants are very young and before they show signs of forming heads.

Cabbage Snakes (*Mermis albicans*).

Alarming stories relative to the poisonous properties of "long, slender, hair-like snakes" which are found in the cabbage, reach us from time to time. These "fearful snakes" are the same creatures that are found in watering-troughs and pools so frequently, they are then known as "hair-snakes," believed by the uninformed to be animated horse-hairs. They really are parasites from the bodies of grasshoppers, crickets, etc., which pass part of their existence in the soil or water, the eggs being hatched in the soil and the young gaining access to the bodies of grasshoppers or crickets early in their career. When a grasshopper is about to die from the drain put upon its strength by the parasite, the latter crawls out. Some fall into the cabbages on which the hoppers happen to be feeding when their strength fails. Such hair-snakes settle down into the cabbage head, finding a moist place wherein they manage to live for some time.

It is not at all likely that harm would result from eating a piece of hair-snake, although the writer has never knowingly tried it. When well cooked, there should be no reasons other than those of sentiment, for fearing them.

INSECTS INJURIOUS TO CELERY.*

AFFECTING THE TOPS.

Celery Aphis (*Rhopalosiphum dianthi*).

Occasionally celery is infested by one of the plant-lice or green-flies. The writer has never seen any serious injury by these insects, but in case they become troublesome, kerosene-emulsion should prove effective as should also tobacco water.

Little Negro-bug (*Corymelaena pulicaria*).

Bulletin 102 of this station contains a description of an outbreak by the little negro-bug. This insect ordinarily seems to prefer weeds

*For further information on celery insects, see Bul. 102 of this station; published also in the Annual Report for 1894.

to celery, but on occasion, it has been known to overspread a celery field in late July, collecting in little clusers on the leaves, and playing sad havoc with the commercial fields. The outer leaves of the stalk suffer first, but later the inner, feathery ones that go to make the market head.

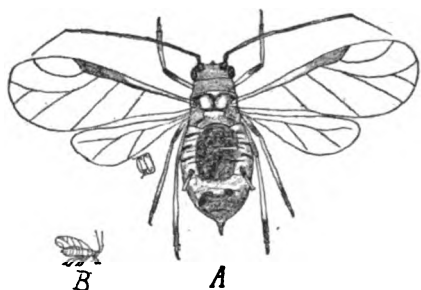


Fig. 25.—Celery Aphis, enlarged, after G. C. Davis.

The cause of all this trouble is a small, shining black bug, very convex and quite broad comparatively, the length being a little less than one-eighth of an inch. The insect is said to rear only one generation each year. It is known to work on strawberry, raspberry, grape, wheat, some grasses, and a number of weeds, including red-root and ground-nut, beggar-tick, plaintain, rag-weed and smart weed.

REMEDIES.

Mr. Davis recommends crude carbolic acid and water used at the rate of a teaspoonful to two gallons of water and sprinkled over the plants or else crude carbolic and air-slaked lime used at the rate of a teaspoonful of the acid to a bushel of lime, and dusted over the plants. The emulsion of carbolic acid described on page 66 and diluted so that the same amount of the acid is found in two gallons of water, will make a more even preparation and one would expect less danger from burning the plants than with the plain mixture. The writer has never had an opportunity to try this, however. Mr. Davis found that hot water killed the bugs when used at 155 degrees Fah. and that the plants were killed at 175 degrees. On a small scale, this can be applied with a sprinkler if care be taken to test the water with a thermometer carefully and at short intervals.

Clean culture.—The long list of weeds which serve as food-plants for this little nuisance, shows plainly that the removal of weeds from the vicinity of the celery fields will be the most effective preventive measure at our command. Clean culture is, after all, a measure which pays well.

Tarnished Plant-bug (see Insects affecting Beets).

Leaf-hoppers (see Insects affecting Beets).

Grass-hoppers (see Insects affecting Sweet-corn).

Celery Thrips (*Coleothrips trifasciata*).

Related to the onion thrips, and in many respects, closely resembling it, is the celery thrips. It is said to be the same species as the one so common in clover heads. Very small and active, this insect jumps and flies away on the slightest disturbance. For a more complete description of thrips, see Insects affecting the Onion.

Celery-looper or Plusia (*Plusia simplex*).

Closely related to the cabbage-looper is the celery-looper. The naked, green larva is marked by eight white lines. The moth closely resembles

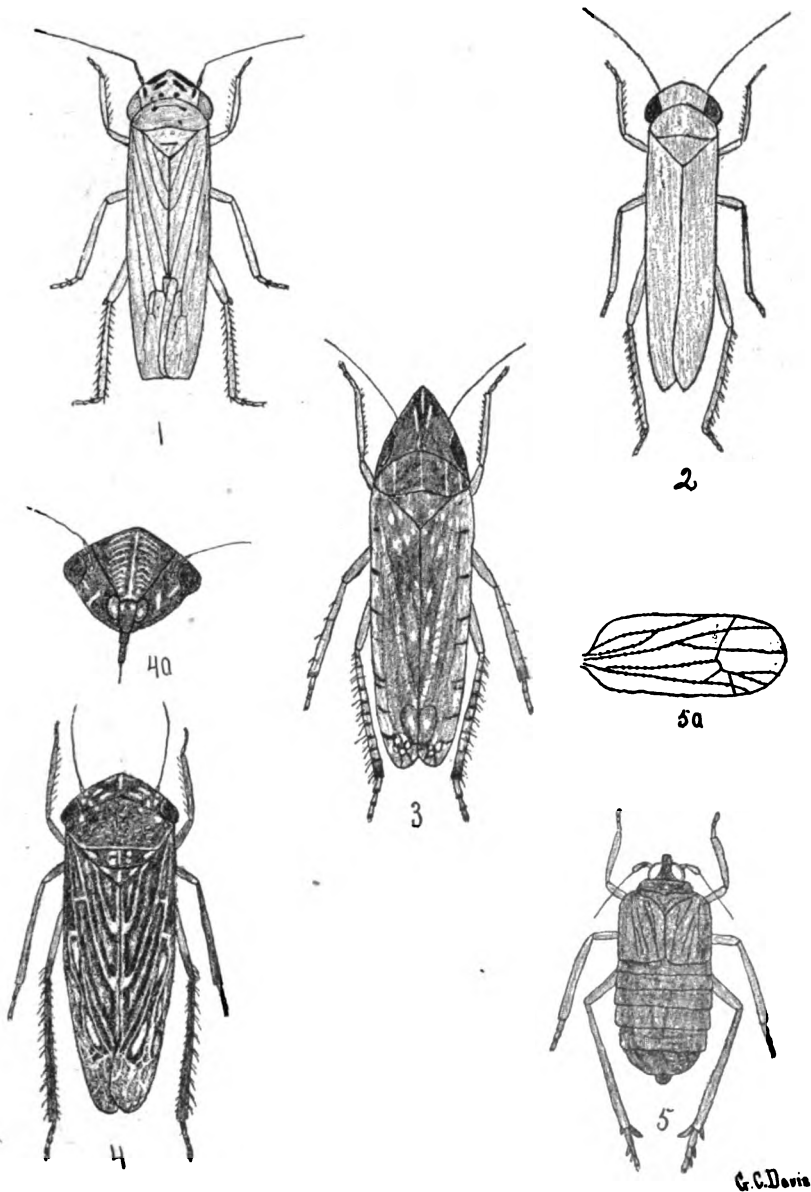


Plate 1.—Celery leaf-hoppers. 1, *Cicadula*; 4—*lineata*; 2, *Empoasca mali*; 3, *Platymetopius acutus*; 4, *Athysanus instabilis*; 5, *Megamelus picus*, all enlarged ten times. (After G. C. Davis.)

the cabbage-looper except that the fore-wings are marked with grey and seal-brown. The silver mark is hook-shaped, and the hind-wings are marked with a dark wash. See also cabbage-looper.

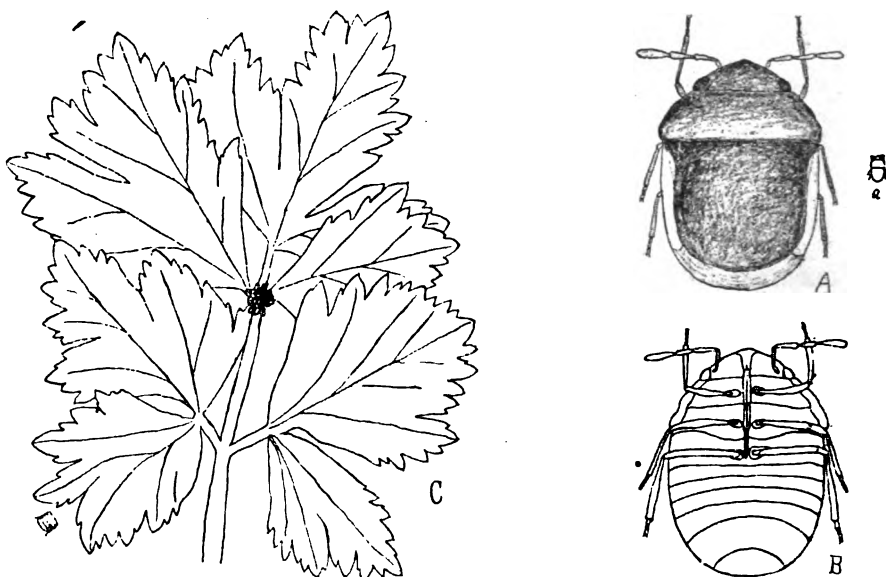


Fig. 26.—Little negro bug. A, upper side; B, under side, enlarged; C, leaf showing bugs at work. (After G. C. Davis.)

REMEDIES.

Of course poisons should not be used, but Pyrethrum and water, applied with an atomizer, should answer all requirements. Apply as when used against the cabbage-worm.

Sulphur-colored Tortrix (*Dichelia sulfureana*).

Mention is made of this little moth in Bul. 102 of this station by Mr. G. C. Davis, formerly consulting entomologist of this station. Mr. Davis says in part: "There are at least two broods and probably three. The larvae are light green all except the tips of their mandibles, labrum, and front feet which are black, and the head and thorax which are lighter, almost a flesh color. They live in leaves drawn together by a web which they spin and feed on the adjoining leaves. They pupate in the same leaves in which they live. The little moths are bright sulphur-yellow with a net-work of small red lines and larger reddish-brown bands on the primary wings. The hind-wings are dusky. The band on the front-wings varies considerably."

REMEDIES.

Clear up all refuse material and burn in the fall. A spray of Pyrethrum-water should kill many if applied forcibly enough to penetrate into the rolls of leaves.

Celery Tortrix (*Sericoris bipartitana*).

Mr. Davis mentions this species as feeding on the leaves of celery. A gallery is made by drawing several leaves together. The larvae are said by Mr. Davis, to be small, slender, and quite active; dark, greasy brown in color, with a black shield on the thorax, and the legs and plate on the anal segment black. There are four shining dots on the upper part of each segment forming a square. The adult moth is black and white with dark posterior wings and light abdomen. The same remedies should apply as in the case of the sulphur-colored Tortrix, should there be sufficient need.

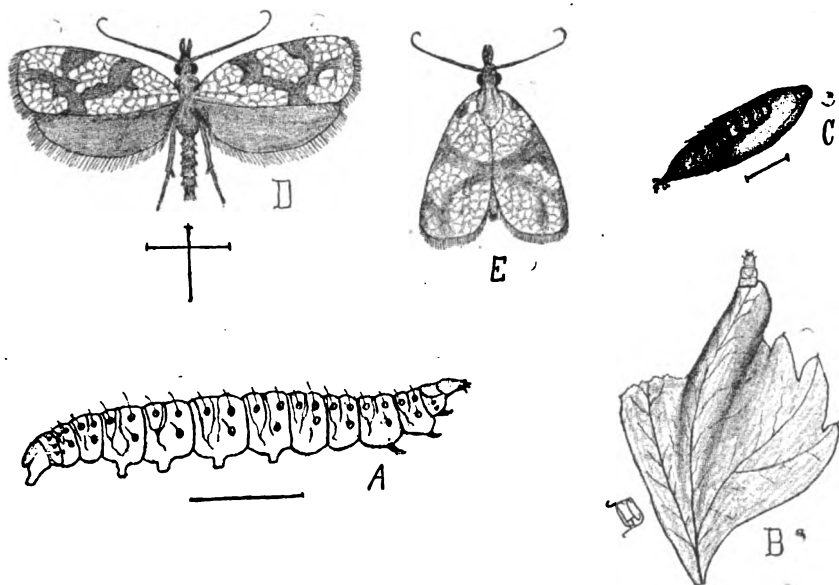


Fig. 27.—Sulphur colored tortrix, enlarged. After G. C. Davis.

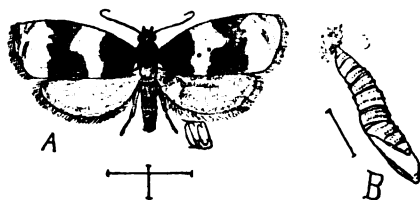


Fig. 28.—Celery tortrix, enlarged three times. A, adult; B, pupa. (After G. C. Davis.)

Celery Borer (*Phlyctaenia ferrugalis*).

In Bulletin 102 of this station, Mr. G. C. Davis describes the celery borer. This insect is said to bore into the crown and to feed on the leaves. The larva is described as being greenish, translucent and about one inch long. The pupal stage is passed in a cocoon or web among the leaves. Mr. Davis describes the insect as follows: "The full-grown

larva is nearly an inch in length. Head and thoracic shield drab, with black markings as shown in the drawing. Along the body is a dark-green dorsal line on each side of which is a very faint almost obscure, dull white line merging to a translucent greenish and bordered by another dull white line. On each side is a very obscure yellowish-green line. There is a distinct caudal shield of white and dark-green. The caterpillar is sparsely covered with hairs. The moth is reddish-brown on the front-wings and greyish-brown on the hind-wings. Both have the faint markings shown in the drawing."

REMEDIAL.

As this insect is rather uncommon and as celery is not a fit plant on which to use the arsenties, it will be best to rely on hand picking.

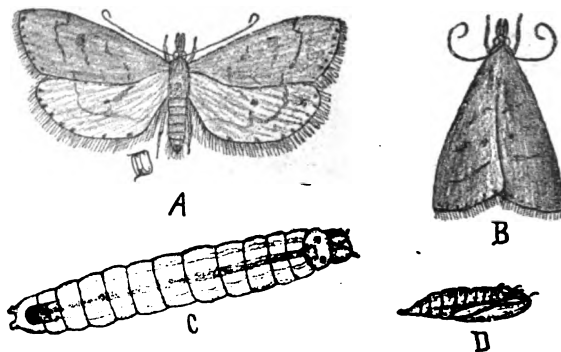


Fig. 29.—Celery-borer, twice natural size, after G. C. Davis.

Cut-worms (*Agrotis c-nigrum* et al.) (see Insects Affecting Sweet-corn).

Zebra Caterpillar (*Mamestra picta*.)

For an account of this insect see Insects affecting the Beet. Of course remedies that are used against this insect on beets, would be somewhat dangerous on celery. Hand-picking will ordinarily suffice, and when they are very plentiful, use a spray of one of the non-poisonous emulsions.

The Parsley Caterpillar (*Papilio polyzenes*).

A common caterpillar on celery, fennel, parsnip, carrot, caraway, etc. is the larva of the black swallow-tail butterfly known in the larval stage as the parsley caterpillar. This conspicuous, naked "worm" is nearly two inches long, green in color, with transverse black bands and spotted with yellow. When disturbed, the larva protrudes a Y-shaped yellow horn, from which emanates a sickening odor, presumably distasteful to birds and other enemies. In the pupal stage, the insect is naked and fastened either to the plant itself or to some adjacent object. The butterfly that comes from the pupa, and which is the parent of the larva, is black, measuring when the wings are outspread, from two to three inches across. The outer margins of the wings are crossed by two rows of yellow spots. At the hind angle of each hind-wing is an

orange spot with a black center. There are many iridescent blue scales near the outer margins of the hind-wings.

REMEDIES.

Hand-picking usually will suffice if the "worms" are on celery, but one of the emulsions should work to perfection, in case they ever become numerous.

Celery Flea-beetles (*Longitarsus melanurus*, *Grepidodera cucumeris* *Chaetocnema parvipunctata*).

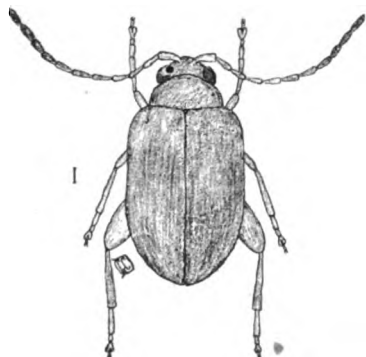


Fig. 30.—Celery flea-beetle (*Longitarsus melanurus*), enlarged. (After G. C. Davis.)

Several species of flea-beetles are known to be partial to celery, the three mentioned by Mr. Davis, are given above. These little creatures do the most harm when the plants are very young. At such times, a spray of bordeaux should act as a repellant if we may judge from its effects in the case of the flea-beetle on potato and others. A spray of tobacco decoction is said to be efficient. Tobacco dust should also prove of some use.

INSECTS AFFECTING THE CUCUMBER.

INSECTS WORKING ON THE FOLIAGE.

Melon-louse on Cucumber (*Aphis gossypii*).

At all times after cucumbers commence to "run" they are subject to attack by a plant-louse. The insect is blackish-green in color and both winged and wingless forms occur. They multiply so rapidly as almost to cover the under sides of the leaves in a short time. Ordinarily in large fields, the attack commences in certain small, well-defined areas, from which the trouble spreads rapidly in ever widening circles rendered conspicuous by the curled and discolored leaves. The source of the pests was for some time a mystery, but Mr. Theodore Pergande, of our National Bureau of Entomology, throws a great deal of light on the subject* when he explains that the same insect feeds also on cotton, orange, melons, strawberry as well as on a long list of our common weeds. In the light of this information, it is easy to see how the pest is kept alive until opportunity to attack melons and cucumbers offers itself.

TREATMENT.

The fact that the pests work almost entirely on the undersides of the leaves, where it is difficult to apply sprays, makes them very serious

pests to combat. The writer has made an effort to select a spray that will kill the greatest number of those hit, trusting to the operator to hit as many as possible and to repeat the application when necessary. Others have found it practical to place a low tent over the plants, and to fumigate with burning tobacco stems and other agents. Such fumigation has given partial success, but seemingly is little, if at all, superior to the sprays. The cost of fumigation is unquestionably greater. The spray that gave the best results with us was whale-oil soap kerosene-emulsion, with Pyrethrum added. (See directions for preparing insecticides.) This was diluted ten times. We succeeded in killing about 99 per cent of the lice, in one trial, doubtless all that were hit. In order to apply this spray with sufficient thoroughness, a knapsack pump was used. This was fitted with a short extension, about three feet long with a Vermorel nozzle set at right angles to the extension, making it easy to apply the spray sidewise and upward from beneath.

As stated, the lice usually start from one or two vines in a field. Careful watching will reveal these centers of infestation and prompt treatment should check their spread in the beginning. Of course it will be necessary to repeat the spray as often as the lice appear. As in the case of the lice on cherry, the difficulty lies in reaching the lice and not in making a spray that will prove effective.

Squash-bug (*Anasa tristis*).

Everyone knows the large black stink-bug or squash-bug of the garden and field. All of us have tried to kill it by sprays, dust-baths and what not, but still the stink-bug flourishes. There seems to be no wash or powder that will kill the bug without at the same time, killing the plants.

The eggs of these marauders are red in color, and quite large, they are laid in patches on the leaves, for the most part, on the underside. The young bugs that come from these eggs resemble the adults very much except in their proportions and in size, although of course they lack the wings. Not only do the bugs attack the vines, piercing them with their long beaks, and extracting the sap, which alone is enough to seriously injure the plants, but, at the same time, they carry the germs of disease from one plant to another, thus inoculating healthy plants with the wilt, and possibly with other diseases.

REMEDIAL.

Plants grown under mosquito-netting of course escape the bugs, but such a measure is very expensive except in unusual cases.

Clean culture.—In the autumn after the crop is secured, the bugs continue to feed on the old vines for some time before the vines dry up and die. The writer has collected large numbers in such situations. Young bugs, old bugs, and bugs half-grown. It is these young and vigorous bugs that hibernate and start new generations in the spring. The remedy is obvious—destroy all old vines, squash, pumpkin, cucum-

ber and all vines of that family, just as soon as they have served their purpose, either plow or burn, and do it *then*.

On cool nights, the bugs love to hide under shelters. Old shingles, placed on the ground near the vines, harbor dozens of the adults over night. The lesson is obvious,—put out pieces of board and shingles and destroy the bugs early in the morning before they get to the vines. Jar the bugs off into pails of water having a little kerosene floating on it.

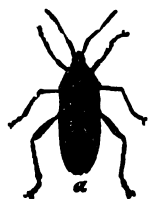


Fig. 31.
Squash-bug.

Cucumber-beetle (*Diabrotica vittata*).

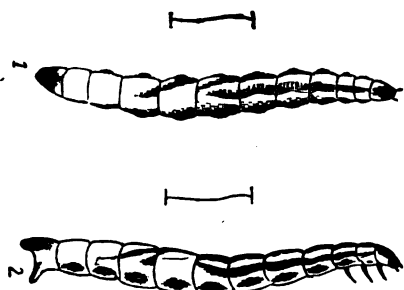


Fig. 32.—Cucumber beetle larvae, enlarged.
(After Riley, Second Mo. Rep.)

The cucumber-beetle, often known as the striped cucumber-beetle, is a small yellow and black creature a little over one-eighth of an inch in length, which feeds on cucumber, melon, squash, and all vines of this family, besides a host of other plants, including sugar beets. It is straw colored with three longitudinal black stripes.

Every owner of a garden is familiar with the little pests that come in great numbers just as the plants come up, eating holes in the young

plants and often killing them before they even get a start. Furthermore the beetles lay their eggs on the stems just under the soil and the larvae or grubs that hatch from them, tunnel their ways through the roots, often killing the plants that escape the winged beetles.

REMEDIES.

Many growers start their plants in berry boxes under cover, and set them out in the field, after the vines commence to run. This helps out a good deal but does not entirely control the pests. Paris-green is rather dangerous and is apt to kill the vines, and their rapid growth makes it necessary to apply very often, causing the poison to accumulate on the older leaves, thus seriously endangering them. For this reason, it is

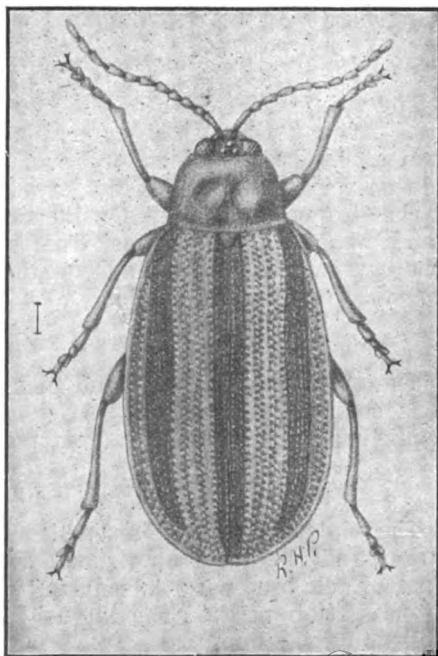


Fig. 33.—Cucumber-beetle, enlarged. (Author's.)

best to dust with something beside arsenicals. The writer has used dry-slaked lime and sulphur for many years and with very good results. Slake the lime dry (air-slaked lime is not as good, for it is not so caustic in its effects). See directions on page 66. Mix one pound of flowers of sulphur with every three pounds of dry-slaked lime and dust on through coarse cloth. Three or four thicknesses of mosquito-netting works better than anything else. Dust on liberally and repeat as the vines grow or rain washes off the old coating. The beetles detest the mixture and if the plants are kept covered, their work will be comparatively insignificant. Weekly applications are usually enough.

Tobacco-dust, or finely ground tobacco thrown about the roots, works very nicely. The writer uses half a handful to a plant. It can be obtained at from one to two cents a pound from the large tobacco factories in the South or from their representatives in the cities. Tobacco-dust is a valuable fertilizer besides killing many insects. By combining these two practices one should be able to raise good crops of cucumbers in spite of the beetles. As the beetles hibernate as adults, clean culture will exert a marked beneficial influence. Plow up the fields just as soon as the crop is gathered.

Cucumber Flea-beetle (see Potato Flea-beetle).

INSECTS AFFECTING THE HOP.

INSECTS AFFECTING THE FOLIAGE.

Hop Merchant (*Polytonia comma*).

The spiny caterpillar of the hop-merchant is known to all hop growers. After a time, these caterpillars change to the naked pupae which are marked with golden or silver spots. From these pupae come the adults, very pretty butterflies of a general brownish color, marked with darker brown and slate. On the underside of each hind-wing is a silver mark, shaped like a comma, from which the insect takes its latin name. The eggs are laid in strings on the leaves. Besides hops, the caterpillars feed on elm and nettle.

REMEDIES.

The only remedies are hand picking and spraying with arsenical poisons early in the season. After the hops form, no sprays should be applied because of danger from poisoning.

The Violet-tip (*Polytonia interrogationis*).

The violet-tip closely resembles the hop-merchant. It is, however, larger and the greys on the wings are apt to take on a more purplish tint. Each hind-wing is marked with a silver spot something like an interrogation mark. The larvae feed on nettle, elm and hackberry as well as on the hop.

REMEDIES.

The treatment is the same as that for the hop-merchant.

Hop-louse (*Phorodon humuli*).

Such a fragile creature as an aphid can hardly hope to pass the winter successfully on such a plant as the hop which is spread on the ground during the cold season. For this reason, a curious habit has been developed. Late in the season, winged sexual forms are developed from the non-sexual form of the lice that have been feeding on the hop all summer, and these sexual forms lay their eggs on the plum trees, where the eggs are in good high situations, safe for the winter except from birds and other enemies. In the spring, wingless forms are produced at first, and from these, winged females which migrate to the hop to become the parents of the myriads of lice which later appear.

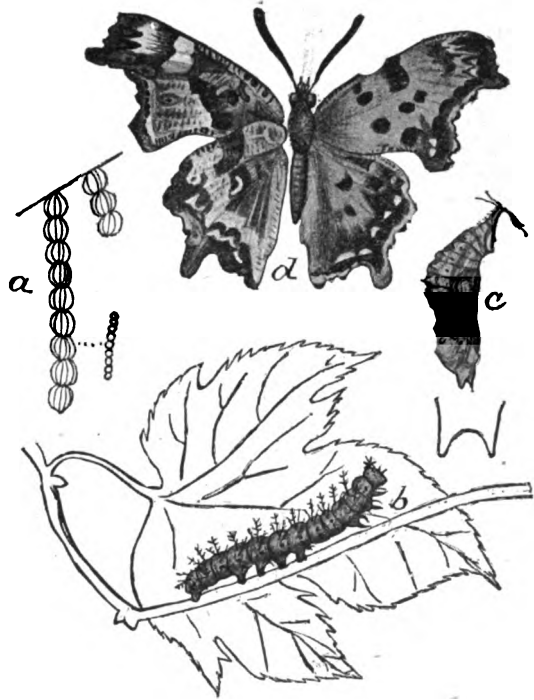


Fig. 34.—Hop-merchant, after Dr. L. O. Howard, Bul. No. 7., N. Ser., Bureau of Entomology, U. S. Dept. of Agriculture

REMEDIES.

The lesson to be learned from this life-history is very easy to see. Avoid having plum trees, either cultivated or wild, near the hop yards. If it is impossible to do this, then spray the plums with kerosene-emulsion, or tobacco-water just as soon as the eggs hatch, and spray with extreme care so as to hit as many of the lice as possible, before they migrate to the hops.

It will be necessary, in many cases, to spray the hops themselves, especially the vines on which the lice first appear, and which serve as centers of infestation for the rest of the field.

Kale (see Insects Affecting Cabbage).

INSECTS AFFECTING THE MELON.

INSECTS AFFECTING THE FOLIAGE.

Melon caterpillar (*Eudiotis hyalinata*).

An insect rather unusual in Michigan but more common south of us is the melon caterpillar. The larva is said to be a little over an inch long, of a greenish-yellow color, and to be clothed with a few scattering hairs. They feed on both the leaves and fruit of plants belonging to the melon family, spinning their cocoons in folds in the leaves. The adults are among the most beautiful of our moths. They measure about an inch across the extended wings and are silvery white except for a border around the front and lateral margins of the wings which is black, the end of the abdomen ending in a buff tip, with black and white markings.

REMEDIES.

The best remedy for this worm will probably prove to be hellebore, a substance that should not injure the delicate foliage of the melon.

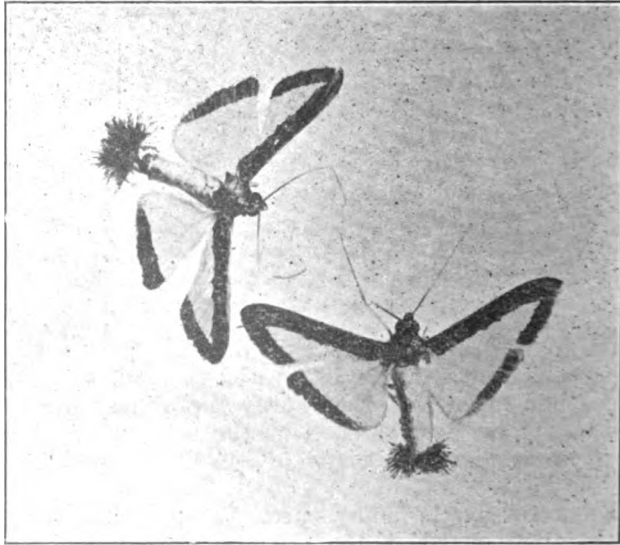


Fig. 35.—Adult moths of melon caterpillar, slightly enlarged. Original

Melon-louse (see Insects Affecting the Cucumber).
Pale Striped Flea-beetle (see Insects Affecting the Beet).
Striped Cucumber-beetle (see Insects Affecting the Cucumber).
Cucumber Flea-beetle (see Insects Affecting the Potato).
Squash-vine Borer (see Insects Affecting the Squash).

INSECTS AFFECTING THE ONION.

INSECTS AFFECTING THE BULBS.

Onion-maggot (*Pegomya cepetorum*).

Besides the barred-winged onion-maggot, we have ranging from the Upper Peninsula to Indiana, the common onion-maggot, so well known and so much dreaded. This maggot is the offspring of a small fly very much like the house-fly in appearance, except for size, being only about half as large as the house-fly. It is a near relative of the cabbage-maggot and the work of the two is very similar. Unfortunately, some



Fig. 36.—Onion-maggot, larvae and pupae, enlarged. Original.

of these onion-maggots pass the winter in the pupal stage and some as adults hidden away in sheltered places. This fact complicates matters somewhat for it necessitates methods of control other than that of merely destroying the pupae by fall plowing.

The eggs are laid on the young plants early in the spring, and the young maggots appear in a short time. When full grown, they go into the soil, change to pupae and later give forth the adult flies. These lay the eggs for succeeding generations, several of which are produced during the season. In the latter part of the season, the onions are each large enough to harbor a number of maggots, and the infested bulbs which are not killed outright, usually rot after harvest.

REMEDIAL.



Fig. 37.—Onion-maggot, adult fly, enlarged.
Original.

The remedial measures consist in repelling the adult flies that come to lay their eggs and in stimulating the young plants to very vigorous growth by means of commercial fertilizers and cultivation. Pull out and destroy the young plants as soon as they show the presence of the pests, and do everything possible to stimulate the plants to rapid growth. The best repellent thus far discovered is carbolic-acid emulsion, diluted thirty times, and applied with a sprinkler. The formula for this is given in the directions for making insecticides. It will be necessary to repeat the application at intervals of about a week, but good work early in the season is sure to count in reducing the numbers of the flies later on.

Barred-winged Onion-maggot (*Chaetopsis aenea*).

Once a deceiver, always distrusted, applies to this dainty and really very pretty little fly. The adults of this insect are commonly seen sitting on corn or reed grass, sunning themselves and darting about, apparently for sheer enjoyment. From time to time, however, disquieting rumors have come in; accusations of transgressions in the wheat and oat fields, in the corn and the sugar-cane. Such reports naturally undermine the standing of our fraud, and it only remained for the accused to attack the onion crop in 1901, to prove his double dealing and to set the hand of man against him, at least in the regions of the rich muck land in the south-central part of the State where such quantities of onion seed are raised. On this occasion hundreds of bushels of onions were destroyed, rotted after harvest or were so wormy at harvest time that they were worthless. Since that time the pest has been so circumspect that we are able to prove nothing against it, although the rearing of adults from a large enough lot of samples, would likely bring some of the flies to light.

The flies themselves are about three-sixteenths of an inch in length and, with the wings at rest, about one-fourth of an inch from the front of the head to the tips of the wings. In color, the back is metallic blue-green except the head which is mostly hoary, with brownish-black eyes. The wings are transversely crossed by three smoky bands, the outer two coalescing at each end.

In our cages, the winter was passed in the onions, the maggots changing to pupae in the autumn, and the flies emerging early in the spring.

REMEDIES.

The fact that the insects pass the winter in the bulb, at once suggests the first measure to be taken. *Destroy all injured onions in the fall.* All young and growing onions should be pulled up and destroyed

as soon as they show signs of infestation, and liberal applications of commercial fertilizers should be applied to stimulate rapid growth, for maggots always prefer slow-growing and sickly plants to vigorous ones.

Apply carbolic-acid emulsion diluted thirty times, along the rows as soon as the plants get nicely above ground.

This has shown the best results and is highly

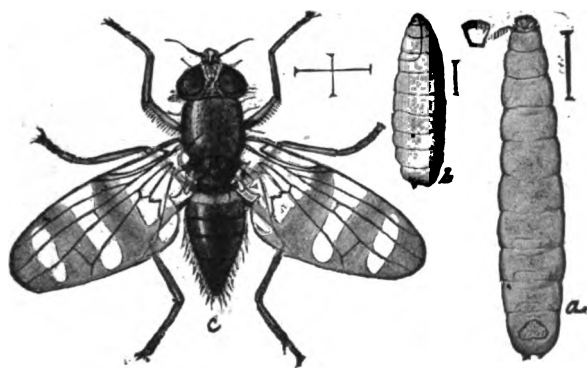


FIG. 38.—Barred-winged onion maggot, enlarged. (From Riley and Howard, *Insect Life*, U. S. Dept. of Agr., Bureau of Ent.)

recommended by Professor M. V. Slingerland against the common maggots. Repeat at intervals of about a week, as long as there is danger, and practice rotation on general principles. Commence early, just as soon as the first young onions show the presence of the maggots.

INSECTS AFFECTING THE TOPS.

Onion Thrips (*Thrips tabaci*).

Tiniest of all the insects mentioned in this paper, is the onion thrips. A little larger than a printed period and very active, it is so small and quick in its movements, that it is usually overlooked. The injury is brought about by the great numbers that collect on the plants. On the onion, the thrips prefer the axillary portion of the plant, where two leaves join. They scrape the soft material off the leaves, giving them a grey or hoary appearance, sometimes noticeable at quite a distance. The leaves or tops decay if the weather turns wet and the keeping qualities of the bulbs are impaired.

The immature insects are usually more abundant than the adults, they are about one-twenty-fourth of an inch in size, and yellowish-green in color. See fig. 39. The body is long and slender, with six legs and six-jointed antennae. The feet, like those of all true thrips are destitute of claws. The adult is shown in fig. 39, at rest with the wings closed, as that is the position in which it is most often seen. The general color is dirty yellow with dusky markings. The antennae are seven-jointed in the adult. The extremely narrow wings are fringed with long hairs giving them a feathery appearance. The time required for each generation is said to be about six days in the South. Here in Michigan, more time will, no doubt, be required, at any rate, a number of broods are developed each year.

An extended account of this pest is given by Mr. Theo. Pergande of

the U. S. Department of Agriculture, Bureau of Entomology, in "Insect Life," Vol. VII., pp. 392-5.

REMEDIES.

Thrips feed by scraping minute particles off from the soft parts of plants, but as far as their control is concerned, they may be classed with the sucking insects, and we must resort to contact insecticides to kill

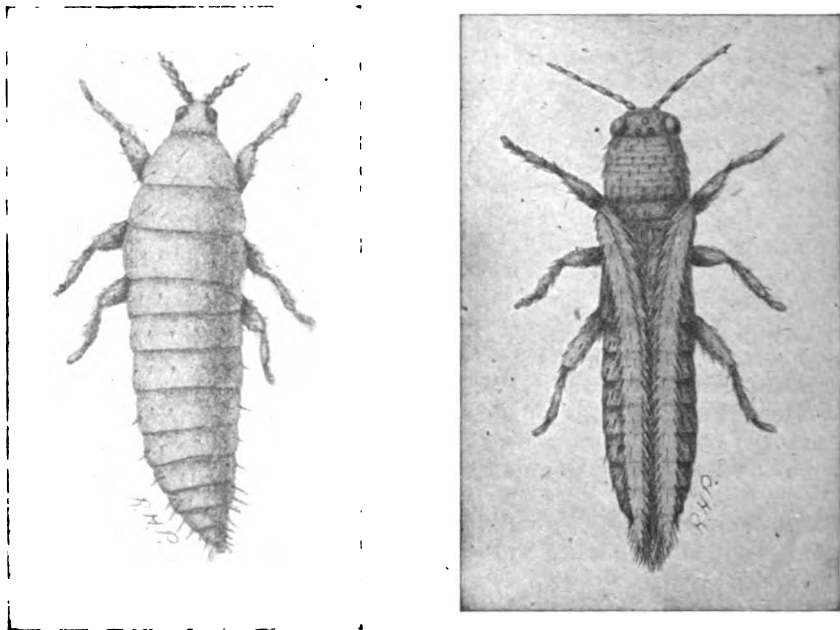


Fig. 39.—Onion Thrips, mature insect at left, and immature at right, greatly enlarged. (Author's illustration.)

them. Kerosene-emulsion, used at the rate of one part of the emulsion to ten of water will kill them. Tobacco water should also prove effective. Drenchings of cold water are said to be useful when practical, for thrips thrive best in a dry, warm atmosphere.

Cut-worms (see Insects Affecting Corn).

INSECTS AFFECTING THE PARSNIP.

INSECTS AFFECTING THE STEMS AND SEED-CLUSTERS.

Parsnip Borer (*Depressaria heracliana*).

At long intervals, we hear complaints from the growers of parsnip seed, of a "worm" that spins webs about the flower-heads, feeding therein, and later boring into the hollow stalk. When this insect

appears at all, usually it is in goodly numbers, and the destruction wrought is pretty complete. Such ravages point to the presence of the parsnip-seed moth, also called the stem-borer. The larvae or caterpillars of this moth enclose the large umbels or flower-heads in webs. Such larvae are about three-fifths of an inch long, yellowish or greenish-yellow in color, with many small, black points on the body. Each point bears a short hair. The head, prothoracic shield and true legs are black. When nearly full-grown, the caterpillar descends to the axil or fork where a leaf is given off, and bores into the stem, where it changes to a brown pupa a little less than half an inch in length, from which the adult miller or moth appears in July. This moth is brownish-grey in color, with minute markings of black. It measures nearly an inch and one-quarter from tip to tip of the expanded wings.

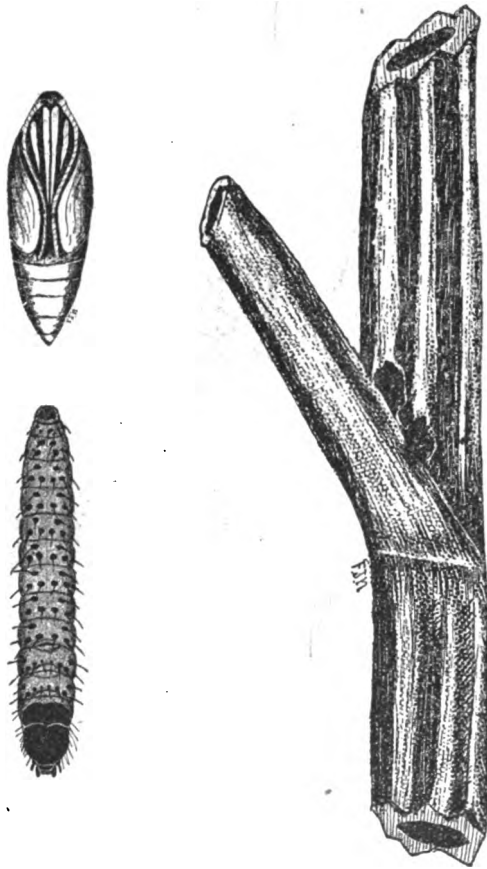


Fig. 40.—Parsnip borer. Pupa, larva and tunnel in seed stalk. (After G. C. Davis.)

REMEDIES.

When the larvae first appear, a spray of paris-green and lime, applied at the rate of one pound of the poison to two hundred gallons of water will kill them. If the application is delayed until the flower-heads are enclosed by the webs, then it will be almost impossible to reach their food with the spray. It will readily be seen that the spray must be put on early so that the "worms" will have only poisoned flowers and seeds to work on. Later after the larvae have bored into the stems, the knife is the only remedy. Cut out and burn the affected parts.

INSECTS AFFECTING THE FOLIAGE.

Parsley butterfly (*Papilio polyzenes*).

One of our most striking caterpillars is the parsley caterpillar which feeds on parsley, parsnip, caraway and other plants of the same family.

In color it is greenish, with transverse, velvety-black stripes many of which are decorated with yellow spots. This is the caterpillar that thrusts out a pair of orange colored horns from just behind the head when disturbed. The sickening odor from these horns serves to protect the caterpillar from many predatory enemies, and often from man. When full-grown, the caterpillar seeks some more or less secluded place and changes to an angular, naked, pupa, from which later emerges a

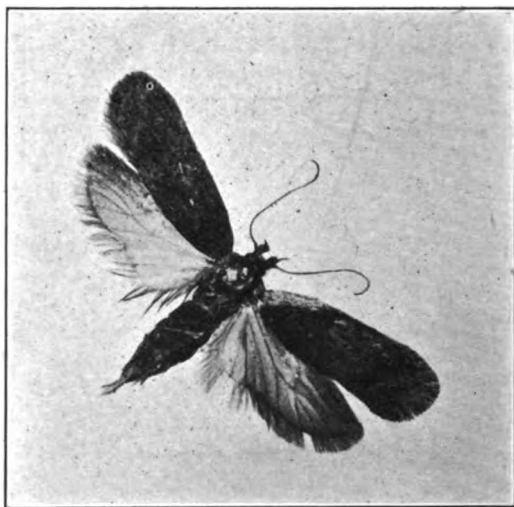


Fig. 41.—Parsnip-borer, enlarged. Original.

beautiful black butterfly having both front and hind-wings marked by two rows of yellow spots, the hind-wings each bearing a short tail. There is also a little blue on the hind-wings and an orange and black eye-spot at the inner angle.

REMEDIES.

In the case of such a conspicuous caterpillar, hand picking is all that is required.

INSECTS INJURIOUS TO PEAS.

INSECTS AFFECTING THE FOLIAGE.

Green Pea-louse (*Nectarophora pisti*).

The green pea-louse is a small aphid or plant-louse, that feeds on a variety of plants, notably clover, shepherd's purse, the vetches, crimson clover and pea. The clovers, vetches, etc., usually sustain a moderate number of these lice, and it was not until the lice appeared in very great numbers on green peas, that attention was attracted to this insect

as a first class pest. As the name implies, the insect under discussion is an aphid or plant-louse of a bright green color. It is of good size, some being winged and some wingless. The winter is passed on clover, preferably crimson-clover, and the winged females migrate to the peas early in the spring. Here they multiply, sometimes to an amazing degree. The loss from a bad invasion of this insect has been as much as half the crop, further south.

REMEDIES.

The methods of combating this insect in other states are two in number—first, the brush and cultivator method, recommended by Prof. W. G. Johnson, formerly State Entomologist of Maryland. When this is used the peas are sown in rows from 24 to 30 inches apart, instead of in drills as is ordinarily done. When the peas become infested and at intervals as required, the lice are brushed in between the rows from the vines and covered by a cultivator before they can get back on the vines. In order to do this, two boys walk in the open spaces between the rows, leaving one space between them, into this middle space they brush the lice with brooms made of fresh-cut pine branches. Just behind them in the middle space follows the cultivator, which buries the lice. If a hot day be selected a large proportion of the lice will be killed.

The other method is that of spraying. Prof. Sanderson, of the Delaware Station, describes* in detail the apparatus used by Messrs. Brakeley of Bordentown, N. J. The machine described sprays four rows at once, and has a device for lifting the vines and spraying from underneath as well as from above. Whale-oil soap is the killing agent used. It is dissolved in water at the rate of one pound of soap to six gallons of water. In hogshead lots, whale-oil soap can be obtained for three to five cents per pound, making the mixture cost less than one cent a gallon.

Experience has shown that this louse works worse on late peas than on early-ones. In some places it has been found profitable to select early varieties for growing so far as possible. While the method of growing peas in rows is apt to cut down the yield in bushels, it allows of cultivation, which has many advantages when quality is an object.

Another item that must not be overlooked is the benefit derived from careful fertilizing. It is a general principle that a crop will withstand attacks by insects much better if in a vigorous, healthy condition. The sap does not seem to agree nearly so well with the insect constitution when the plant is strong as it does under other conditions. Especially is this true with plant-lice and scale-insects. Therefore fertilize well, cultivate well and be prepared to fight on the first appearance of the lice.

INSECTS AFFECTING THE SEEDS.

Pea-weevil (*Bruchus pisorum*).

Buggy peas, like buggy beans, are seeds scooped out by small beetles. The beetles working on these two plants being closely related, but quite distinct in their habits. The pea-weevil is larger than its relative of the bean, and what is more important, the pea-weevils do not continue

* Twelfth Annual Report Delaware College Agr. Exp. Sta. for 1900, p. 175.

to breed in the dried peas after they are gathered, as do those of the bean, but work singly in the seed while the pea is yet green. The eggs are pushed through inside the pod by the mother beetle. For this reason it is possible to control the pest by saving the seed over for two

years, providing, of course, against the escape of the adult beetles when they come out of the seed. Under these conditions, all the beetles come out during the first summer, hence the seed will be free by the following summer. Such a course has its disadvantages because of the deterioration in the seed and usually it is found better to fumigate buggy seed with carbon bisulphide during a warm spell. Always select a warm time for this work as the beetles are more active and therefore more susceptible to the gas.

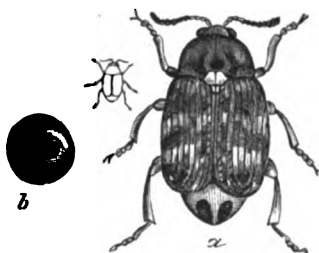


Fig. 42.—Pea-weevil, enlarged, and pea, showing work of beetle. (After Riley, Third Mo. Rep.)

INSECTS AFFECTING THE POTATO.

INSECTS AFFECTING THE TUBERS.



Fig. 43.—Mole-crickets. (Original.)

Mole Cricket (*Gryllotalpa borealis*).

The northern location of our State is responsible for our escaping many of the bad pests of warmer regions. Many insects that are first

class pests in the South do merely nominal injury here. It would be strange indeed if some of these advantages were not partially offset by a few distinctly northern forms. Such an enemy we have in the mole-cricket. We can hardly call this a serious pest, since its attacks are only occasional and for the most part, limited to damp, mucky soils. The mole-cricket is a large, burrowing insect, having its front feet fitted for rapid digging very much like those of the common mole. Like the mole, this cricket lives underground, from time to time appearing in large numbers. Nothing pleases the mole-cricket more than to have potatoes planted in his domain. The tubers are tunneled through and through, the blackened cavities sometimes leaving little more than a shell outside.



Fig. 44.—Work of mole cricket in potato. (Original.)

REMEDIES.

Owing to the fact that these crickets are so irregular in their habits, it has been difficult to carry on successful experiments with them. In Europe, pits are dug in the soil and filled with horse-manure. The pits are said to attract the pests by their warmth, and to shelter them during the late fall. On the outside are placed poisoned vegetables such as potatoes. It would seem that small pits filled with the tunneled tubers

soaked in arsenic-water, to which has been added a little salt, should prove efficient. Of course it is well to avoid planting potatoes in ground stocked with the crickets.

Wire-worms (see Insects affecting Sweet-corn).

INSECTS AFFECTING THE TOPS.

Potato Lice.

Several species of plant-lice attack the potato and from time to time we hear from them in Michigan. Little is known regarding their life-histories, further than the fact that they sometimes appear in numbers to the serious detriment of the plants.

REMEDIES.

Some of the contact insecticides, such as kerosene-emulsion, tobacco-water or dilute whale-oil soap, should be applied in the form of a spray, always bearing in mind that such insecticides work by contact and that each insect must be hit to be killed.

Pale Striped Flea-beetle (see Insects affecting the Beet).

Old-fashioned Potato-beetle (*Epicauta vittata*).

Before the advent of the Colorado potato-beetle, the vines used to suffer from the attacks of a striped blister-beetle, now known to the older potato raisers as the old-fashioned potato-beetle. Since the arsenites have come into such general use, this creature has fared badly, many of them being killed unwittingly together with the Colorado beetles. For the life-history and methods of control of this insect, see Insects of the Beet.

Tomato Stalk-borer (see Insects affecting Tomato).

Potato Flea-beetle (*Epitrix cucumeris*).

Besides the Colorado beetle, one often meets the potato flea-beetle, sometimes called the potato-flea. Like most of the flea-beetles, it is a tiny creature which jumps with surprising power and suddenness.



Fig. 45.—Potato flea-beetle, enlarged. After Chittenden, Bul. 19, N. Ser. Bureau of Entomology U. S. Dept. of Agriculture.

These little beetles riddle the leaves of the potato, tomato, egg-plant and other plants with small round holes. The beetles are very small, about one-tenth of an inch in length, and black in color. The larvae are said to tunnel in the roots of various plants and weeds, notably those of the nightshade or potato family, transforming to pupae in the soil and later emerging as adults. There are two or more generations each year, the adults of the last brood passing the winter among fallen leaves and other rubbish.

REMEDIES.

Clean culture destroys the winter quarters of this and many other pests. Rake up and burn all rubbish late in the fall during a cold spell.

Some years ago, Mr. E. G. Lodeman, then of Cornell University Experiment Station, discovered that potatoes sprayed with bordeaux mixture for the blight were avoided by the beetles. This led to some experiments which showed that a number of flea-beetles were repelled by the bordeaux. Use the ordinary mixture, the formula for which is given on another page of this bulletin, and add one-fourth pound of paris-

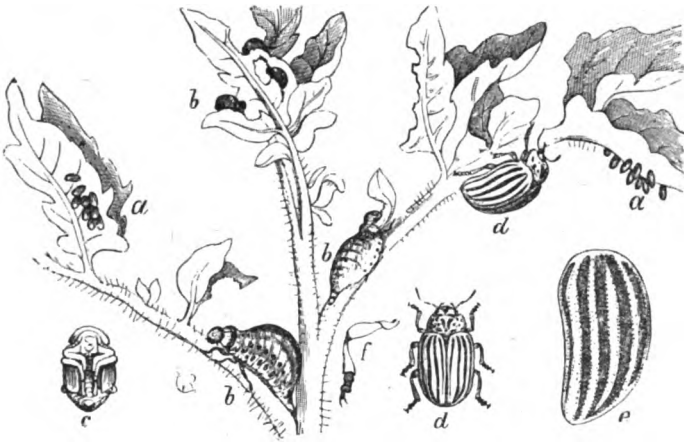


Fig. 46.—Colorado potato beetle. (After Walsh and Riley, American Entomologist.)

green to each fifty gallons of the mixture. The paris-green kills some of them and incidentally many other chewing insects. The cost of the paris-green is insignificant when compared with that of preparing and applying the bordeaux.

Potato-beetle (*Leptinotarsa 10-lineata*).

Pre-eminent among potato insects stands the Colorado potato-beetle. So familiar is this pest that no description is necessary, either of the yellow and black beetle with the ten longitudinal lines on the back or of the reddish-brown larvae that occur in such numbers on neglected potato plants. Up to the middle of the nineteenth century, this beetle was content to feed on weeds belonging to the potato or nightshade family in Colorado, but as farming progressed westward, the more choice and acceptable Irish potato reached the region inhabited by the beetle. The result was like spreading straw slowly up to a bonfire. When it once started, the spread was most rapid, the beetles invading more and more territory until now we expect to find the beetles wherever we find the potato.

The life-history of this pest is quite simple,—the eggs are laid in



Fig. 47.—Eggs of parasitic fly (*Phorocera doryphorae*), on potato beetle. Author's illustration.)

patches on the potato tops, usually on the underside of the leaves, and the larvae feed openly on the foliage until full grown, descending into the soil to change to naked, yellowish or orange colored pupae. After a short time, these pupae transform into the adult beetles which ascend to the surface and feed with the larvae, laying the eggs for another generation, the last generation, for the most part remain in the soil over winter as adults, and come forth in the spring in time to attack the early potatoes just as they come up.

REMEDIES.

The ease with which the potato-beetle responds to the arsenites is so well known that it seems almost superfluous to discuss the question at all. Paris-green, arsenite of lime, Kedzie mixture and others work admirably. Paris-green may be used either as a spray or as a dry powder. The spray has been in favor for many years. It is economical, and when prepared with lime, about as safe as can be desired. It should be applied in rather a stronger mixture than when used for fruits—say one pound to 125 gallons of water or even 100 gallons. Arsenite of lime and Kedzie mixture are both cheaper than paris-green, but white arsenic looks too much like flour and other articles of food to be stored about the house, then too, the work of preparation counterbalances the saving unless the work is done on a very large scale, and in any case special keetles should be provided for boiling. London purple contains more free arsenious acid and is less apt to be uniform in composition than paris-green.

INSECTS AFFECTING THE RADISH.

INSECTS AFFECTING THE ROOTS.

Radish-maggot or Cabbage-maggot (*Phorbia brassicae*).

Everyone that raises radishes, knows of the little maggots that tunnel in the roots. These are the same maggots that work in cabbage roots, being then known as cabbage-maggots. For further information concerning the appearance and life-history of this insect see Insects affecting Cabbage.

REMEDIES.

The best remedy for the maggot when working in radish, seems to be the carbolic-acid emulsion, diluted about thirty times with water. Sprinkle this along the rows of radishes about once a week. The odor drives away many of the flies that come to lay their eggs.

In Canada, they have had some measure of success with cloth covered frames used as a protection. Light frames, three to six feet high, enclosed on all sides with cheese cloth, are placed over the beds. The flies are said to leave such protected plants alone. If this proves successful, it will solve the question in the small kitchen garden at least. In the large market garden it is possible that the expense may eat up the profits.

INSECTS AFFECTING THE FOLIAGE.

Cucumber-beetle (see Insects affecting the Cucumber).

INSECTS AFFECTING RHUBARB.

Tomato Stalk-borer (see Insects affecting Tomato).

Rhubarb Snout-beetle (*Lixus concavus*).

Rhubarb is usually free from insect pests, there is, however, a long, slender snout-beetle, which is to be found early in the spring and late in the fall, resting on the plants. It is dark grey in color and covered with a rust-colored powder that rubs off easily. This beetle is the parent of the white, grub-like borer that tunnels in the leaf and flower-stalks, and the eggs of which are laid in small cavities cut in the tissue of the plant. It is said that the practice of removing the old leaves regularly will take care of the pest, as the borers will in this way be destroyed just as fast as they come, and the new stalks will be found to be free after a little time. The insect also feeds on dock, and for this reason, it is well to destroy all the docks in the vicinity of the rhubarb plants.

INSECTS AFFECTING THE SQUASH.

INSECTS AFFECTING THE ROOTS.

Squash-vine Borer (*Melittia ceto*).

It often happens that squash-vines suddenly wilt, just as they are getting a nice start. This may be due to one of several causes, sometimes a bacterial disease is the cause and sometimes one of the fungus diseases, often, however, one finds on examination that there is a grub-like borer in the hollow stem, and that a tunnel has been gnawed down into the roots. Here the borer dwells, sometimes above and at others below the level of the soil. When full-grown, this grub leaves the tunnel and pupates nearby in the soil. In the following spring the adult appears. The adult is a very pretty insect belonging to the family of moths known as clear-wings, because the wings of many of its members are partially transparent. The moth of the squash-borer measures about one and one-fourth inches across the extended wings, from tip to tip, the front-wings being green and the hind-wings clear. The body is reddish except for the basal part which is green like the front-wings. The hind-legs each bear a fringe of long hairs. The species is said to be single brooded in this part of the country. Further south it is double-brooded.

REMEDIES.

The remedies for this pest are three in number. The results are most satisfactory when all three are used together.

Trap plants.—Fortunately the borer works in summer-squash as well as in the winter varieties, the summer-squash planted between the rows of winter-squash, will attract the majority of the borers. Later, when

they have all become settled in their burrows, the early varieties may be pulled up and burned leaving the later ones free from the borers. Many times it is possible to cut out the larvae by making a longitudinal slit in the vine.

Starting new roots at the joints.—Last, but perhaps best of all, the vines may be induced to put out roots at short intervals by placing a little soil over the joints, thus supplying plenty of food to the vine even after the tap-root has been destroyed. If the plant escapes until it has commenced to run well, it is easy to induce roots to grow by pulling a couple of hoofuls of soil over some of the joints.

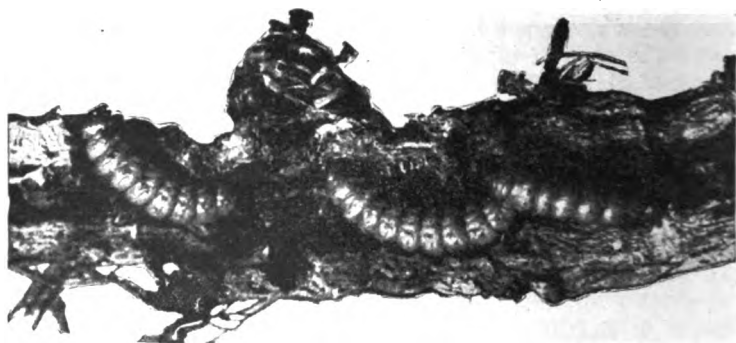


Fig. 48.—Squash-borer larvae in tunneled vine, enlarged. After Prof. J. B. Smith

INSECTS AFFECTING THE FOLIAGE.

Cucumber-beetle (see Insects of the Cucumber).

Squash-bug (see Insects affecting the Cucumber).

INSECTS AFFECTING SWEET-CORN.*

INSECTS AFFECTING THE SEED IN THE GROUND.

Ground-beetles (*Agonoderus pallipes*).

From time to time, one hears that seed corn refuses to germinate, and whole fields have to be replanted. This usually occurs during a wet cold spring. A careful examination of such seed which has lain in the ground for some time, shows, in some cases at least, the presence of a small beetle in the kernel. Sometimes almost the entire contents of the kernel is found to be gnawed out, leaving a mere shell consisting of the hard, outer coat. This form of injury seems to occur over rather extended areas when it occurs at all. The writer had noticed very few instances before the spring of 1904, when a number of complaints together with specimens of the culprits came in. The beetles that do the injury are elongate, flattened, and of a brownish-yellow color. The

* As the aim of this bulletin is to cover garden and truck crops only, and not those of the field, only such are included as are likely to attack sweet-corn. It is intended to discuss methods such as can be applied satisfactorily on a comparatively small scale.

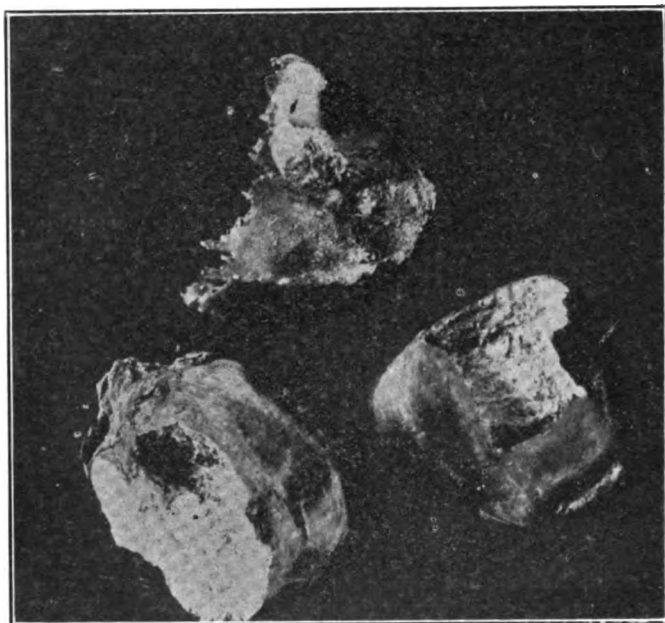


Fig. 49.—Work of ground-beetle (*Agonoderus*), in planted seed-corn, enlarged. Original.

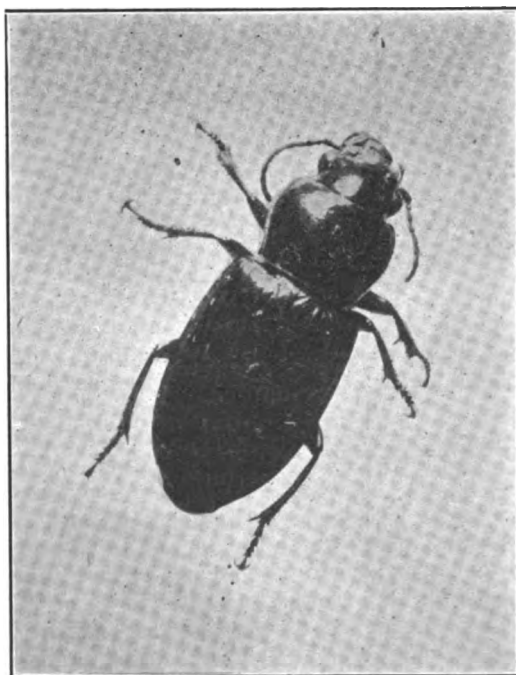


Fig. 50.—Ground-beetle (*Pterostichus*), working with *Agonoderus*, in seed-corn, enlarged. Original.

thorax is reddish-brown and the head black, the middle part of each wing-cover being almost black. The legs are brownish-yellow.

This insect belongs to a family known as ground-beetles most of which are predatory in their habits, feeding on other insects and helping materially to keep our foes in bounds. The food of this species ordinarily consists of other insects, mites, etc., but for some reason, possibly because of the temporary scarcity of its customary food, it departed from its every-day habits in the manner described. Several other species of ground-beetles have been sent in with the guilty ones, but although they may have helped to eat the corn, there seems to have been no more serious charge yet proven against them other than that of being in very bad company.

REMEDIES.

Corn soaked before planting, and rolled in poison and dry-slaked lime or paris-green and plaster, should be immune to attacks by such pests.

(*Clivina impressifrons*.)

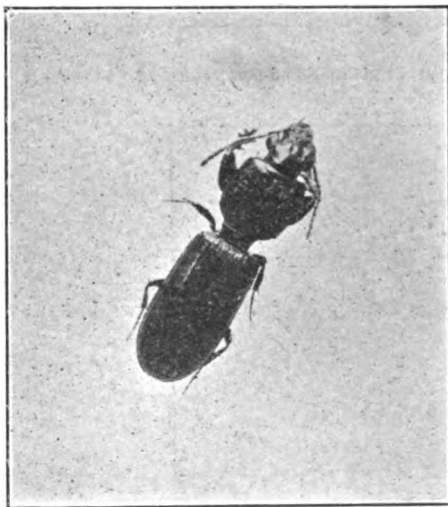


Fig. 51.—*Clivina impressifrons*, enlarged. Original.

This little ground-beetle, about one-fourth of an inch long, was found near Trenton, Mich., feeding on kernels of corn just after they were planted. Like the *Agonoderus*, this little creature belongs to the family of ground-beetles, and ordinarily feeds on living prey. However, in this case, it was doing serious injury, being present in a large proportion of the hills. It has been detected once before in like mischief, by Professor F. M. Webster in Indiana. At that time the trouble occurred about June 11th. The case near Trenton occurred about June 5th. The injury is described by Mr. John Gault, from whom the specimens

were received. He says: "The corn is badly eaten and I took one of the beetles out of the small hole at the germ of one kernel. At the rate he was eating his way in, I am sure it would not take many days to destroy the entire germ." In company with the *Clivina*, were two other species of ground-beetles, which, if not actually found to be partaking at least were open to suspicion. The trouble was found in field-corn but there is no reason to believe that sweet-corn would have escaped.

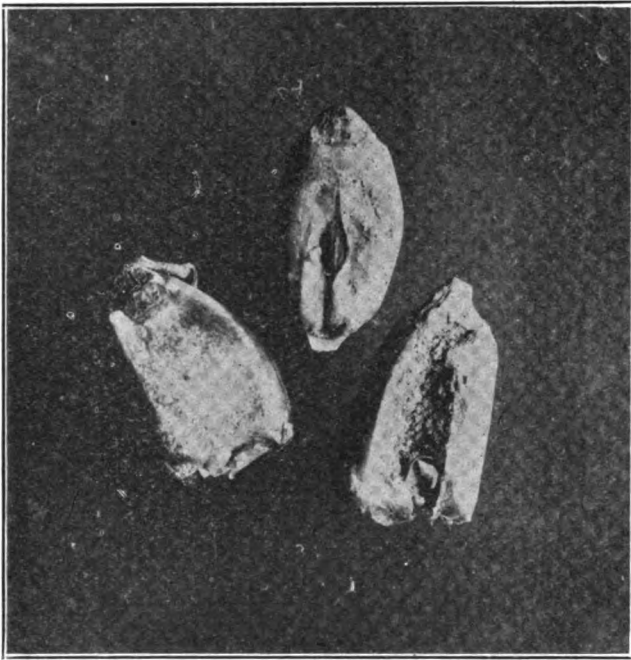


Fig. 52.—Works of *Clivina impressifrons*, in planted seed-corn, enlarged. Original.

Wire-worms (*Agriotes mancus* et al.).

Low ground and more especially mucky ground, is apt to be infested with wire-worms. These are slender, yellow, little creatures, cylindrical in form, and in size varying from half an inch to more than an inch in length. All have hard, polished skins amounting almost to shells, and six short legs just behind the flattened head, besides a sucker-like false-foot on the last segment. Wire-worms usually feed on the roots of grains, corn and other grasses, though they will not refuse potatoes when occasion offers. There are many species to be found in Michigan, and while one may prefer corn, another wheat, and so on, they may all be considered as injurious, except those found in rotting wood, and treated together as far as we are concerned. The adults are the common snapping-beetles or click-beetles, the little fellows that jump up into the air with a click, when placed on their backs. These beetles lay the eggs from which the wire-worms hatch, and the wire-worms in turn become click-beetles after passing through a chrysalis stage in their little earthen cells in the soil. It is probable that two years are required by the larvae to attain maturity. The winter is passed in little cells in the soil in some cases, while in others the adult beetles emerge in the fall and hibernate.

Wire-worms are primarily insects of grassland and the fact that they require two or three years to develop helps to explain why it is that

they are often worse the second year after grass than they are the first, most of them being full-grown at that time.

REMEDIES.

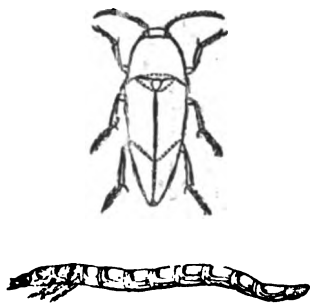


Fig. 53.—Click-beetle, adult of wire-worm and larva, slightly enlarged.

In corn, the most noticeable injury is to the seed after planting, though the larvae also feed on the roots after the corn is up. A long series of experiments by Professors Comstock and Slingerland of Cornell University, failed to show any practicable method of treating the seed so as to prevent injury by wire-worms. They did show, however, that late fall plowing killed many of the pupae and adults by breaking open the earthen cells in which they were. They failed also to kill the wire-worms by any of the commercial fertilizers or insecticides, unless these were used in excessive quantities.*

Professor S. A. Forbes, State Entomologist of Illinois, proposes a rotation of crops in which clover shall always follow grass, and corn shall always follow clover. Plow the grass in early fall, and sow clover, either with oats, wheat or rye. Allow the clover to stand two years and follow with corn.†

On general principles it is well to use wood-ashes where obtainable, because of their tonic effect on the plants. It is understood, of course, that these practices are recommended for aggravated cases of wire-worm infestation and not for regular use in the absence of the pest in dangerous numbers.

INSECTS AFFECTING THE ROOTS.

Corn-root Web-worm (*Crambus zeelus*).

Although Michigan has, thus far, escaped injury from this pest. Illinois and Ohio have not been so fortunate, and it would not be surprising to find it at work in our State at any time. The method of attack is quite characteristic of the pest so that it is not likely to be confounded with anything else. The little caterpillar or larva, works on the roots beneath the soil surface, and each larva is protected by a small web of silken material. The adult moth is white, marked with silvery bands. It is about three-fourths of an inch in length.

REMEDIAL.

The natural food of the corn-root web-worm is grass, and for this reason it is well to avoid planting corn on sod land in places where the pest abounds.

* Bul. 33, Cornell University Experiment Station.

† Rep. State Bd. Agr., 1893, p. 50, containing 18th Rep. State Ent. for 1891-2. A Monograph of Insects Injurious to Indian Corn, Part I.

Plant-lice on Roots (*Aphis maidi-radici* et al.).

In his exhaustive report on Insects affecting Indian Corn,* Professor S. A. Forbes mentions six species of plant-lice which infest the roots of corn in Illinois. One of these, *Aphis maidi-radici*, is considered primarily a corn insect. We have thus far failed to meet the pest in Michigan but we may do so at any time. Like most root-lice the species is associated with ants, in the absence of which the lice would probably do little harm.

REMEDIES.

Professor Forbes suggests several remedies,—change of crop after serious infestation, in a word, rotation. Plowing and thorough harrowing in the fall to break up the ant's nest, and starvation of the young lice that hatch out before the corn is planted. This is done by keeping down the growth of young weeds early in the season, especially smartweed and pigeon-grass.

June-beetles or White-grubs (*Lachnosterna* spp.).

White-grubs are found in the soil under sod, among grass-roots, in corn-fields, strawberry plats and in a great variety of situations. They pass under a number of different names but are best known by that of white-grub. When at rest, they are curved in the form of a horse-shoe, covering an arc about as large as a five-cent piece. White and soft, except for the head and six legs, and a row of breathing pores along the sides, they are delicate, watery creatures, with awkward gait and feeble-powers of locomotion. The adults are snuff-brown beetles from one-half to nearly an inch in size; heavy bodied and blundering in flight. They come in swarms to electric lights and are also attracted to lamps in living-rooms. The grub feeds on the roots of grass and other vegetation, being especially fond of corn roots. The adults feed on the leaves of trees and other vegetation.

The eggs are said to be laid in grass land and the young probably require two years to develop, the pupal stage being passed in earthen cells in the soil.

REMEDIES.

Late fall plowing breaks up many of the cells and exposes the inmates to their enemies and to the weather. As they breed most freely on sod

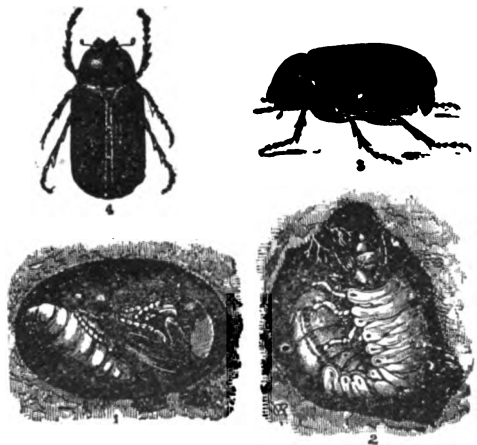


Fig. 54.—June-beetles. From Riley, Rep. State Entomologist of Missouri.

land, it is well to arrange the rotation so as to avoid, as far as possible, bringing corn and grass together, in land subject to their invasions. They are especially apt to be killed off by diseases and natural enemies, so that they come and go with no apparent reason for so doing. They seldom remain very numerous in one field for more than one or two years, because of these enemies and diseases.

INSECTS AFFECTING THE STALK.

Corn-stalk Borer (*Helotrypa atra*).

In his report for 1888, Professor A. J. Cook records a corn-stalk borer from northern Michigan. He describes the injury as quite serious due to a longitudinal tunneling of the growing stalks. The larvae of this insect are said to be much like the ordinary army-worms, and the adults closely resemble the moths of the common cut-worms. The writer has not, as yet, seen this pest.

Barred-winged Onion-maggot (*Chaetopsis aenea*).

This insect is discussed among the onion insects. It has not, thus far, been found in corn in Michigan, but is recorded as having worked in corn-stalks in Maryland. As it is common in our State, its name should be included as a possible sweet-corn pest.

Bill-bug (*Sphenophorus sculptilis*).

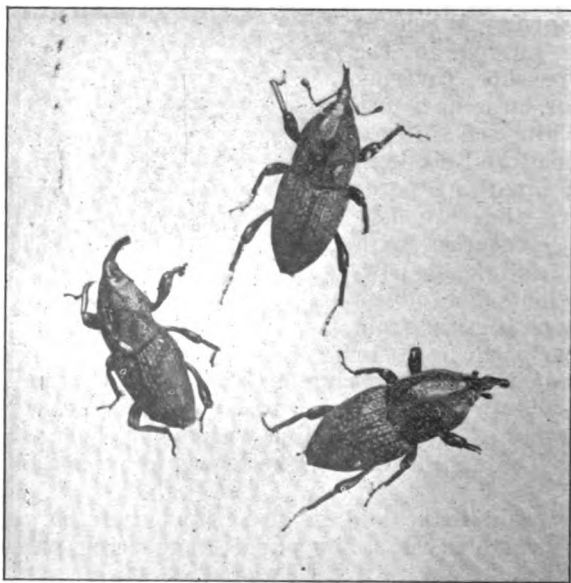


Fig. 55.—Corn Bill-bug, enlarged. Original.

A few hundred miles to the south of us, the corn bill-bugs are not so uncommon as in our State. The season of 1904, however, witnessed the demolition of several large corn fields by this destructive pest. The

first symptom of trouble is the wilting of the young corn. If an examination be made immediately, small black beetles, less than one-fourth of an inch in length, will be found boring into the plants just above the crowns. The beetles have long snouts like the *curculio* but are deep black in color. Fortunately there is but one brood each year, and the injury, as far as corn is concerned, is done by the adult beetles alone.

REMEDIES.

While the bill-bug is known best by its work on corn, it is really timothy that suffers the most from its ravages. Working as it does in the bulbous roots of the timothy, it is able to pass unnoticed unless it occurs in very large numbers. Here in the timothy bulbs, are passed the immature stages, the adults emerging at just the right time to attack the young corn. The moral is not to plant corn after timothy in places where one has reason to fear the presence of the beetles. When the beetles have once come out and done their work in the corn, there seems to be no danger from re-seeding, for there is but one generation each year and the beetles require timothy for their early development.

INSECTS INJURIOUS TO THE FOLIAGE.

Corn Leaf-aphis (*Aphis maidis*).

Seasons that open with a wet spring, followed by moist weather in early summer are usually aphid years. During such years, we usually hear from the leaf-louse of corn. Fortunately in Michigan its visits are not numerous, and when it does appear, it usually starts from some few points in the field, spreading slowly, and that too, after the plants have had a chance to get a good start.

Plants infested with such lice, are easily distinguished by their sickly appearance and by the numbers of lice on the leaves.

REMEDIES.

In the garden, prompt spraying of the infested plants with kerosene-emulsion or tobacco-water will check the lice and prevent their spread.

Grasshoppers (*Melanoplus atlantis*, *M. femur-rubrum*, *Camnula pellucida*).

Of the many forms of grasshoppers known in the United States, Michigan has less than half a dozen of real economic importance, and of these we may consider three as pests of the garden. They are, the lesser migratory locust, the red-legged locust, and the pellucid locust. Of these, the first two look very much alike, and as far as their appearance goes, they may be treated as one. They are both dull olive-green in general color, with an oblique yellow stripe under the wings. The hind-legs are red. The species look so much alike that it is an almost hopeless task for the farmer to distinguish between them; their habits, however, are not quite the same. Grasshopper outbreaks, in our State, are quite likely to be due to large numbers of the lesser migratory species, rather than of the red-legged locust. The pellucid locust is smaller than the other two, and brown in color. The wing-covers have the basal half brown, and the apical half translucent except for spots

of brown. In our State the pellucid and lesser migratory locusts sometimes work together, the most serious of the Michigan outbreaks being brought about in this way.

The life-history of our native hoppers is quite simple. There is but one generation each year, the young coming out in May or June. When first out of the eggs, the little creatures are so small that they easily escape detection, but as time goes on, and they become larger, they require so much food that their work becomes noticeable. When full-grown, the grasshoppers lay their eggs in pods in the soil, selecting dry situations in sod where possible. They like old slashings, lanes, etc. The eggs are laid in pods of twenty or thirty, each pod being coated with a thin covering of brittle material which consists of dried mucus ejected with the eggs. This covering is waterproof. It is replaced at the upper end by a plug of frothy material through which the young can make their way in the spring. The egg pods are placed in the soil or among the grass roots, never more deeply than the length of the mother's abdomen.

REMEDIES.

Three methods of combating grasshoppers are feasible in Michigan, each being suited to its own conditions. Other methods are practical elsewhere but do not seem to commend themselves in our State.

Fall plowing.—This is most efficient where it is possible at all. Plow the egg-pods under, burying some, and breaking open others so that moisture can get in, and exposing still others to the attacks of their enemies,—birds, shrews, etc.

Poisoned baits.—The second method is that of poisoned baits. Use either poisoned bran or the Criddle mixture. Poisoned bran can be used only in situations where stock and poultry are excluded. Neither should they be used where partridge and quail are likely to feed. It is merely bran poisoned with paris-green or arsenic, two pounds of paris-green to twenty-five of bran, moistened with water and a little molasses, so that the bran will just stick together when taken up with a spoon.

Criddle mixture is horse-manure mixed with arsenic and slightly salted. It is to be distributed about the fields in small masses. We all know of the fondness of grasshoppers for anything containing salt. They will even roughen fork handles in their efforts to get at the salt deposited on them with the perspiration. This mixture is recommended in Canada and in some of the western states. The proportions are about as follows: Paris-green, one pound; salt, two pounds; fresh horse-droppings, 100 pounds. The horse-droppings are usually measured out in a three-gallon pail. Five pailfuls being taken as the right amount for one pound of the poison. The salt is dissolved in a pail of water, the poison stirred in, and the whole mixed with the droppings in a half barrel. The writer has not had an opportunity to test this bait as yet, but if it turns out to be as effective as some have claimed, it should be preferable to bran, because of its comparative safety, if for no other reason.

Hopperdozers.—A hopperdozer is a long, shallow pan of sheet-iron, set on runners and having behind it a banner or sail made of canvas or muslin stretched on a wooden frame. The bottom of the pan is covered with rags or old carpet, previously wetted with water. When all is

ready, a pint of kerosene is poured over the wet rags, and the banner of cloth is also moistened with kerosene. The dozer is then dragged on its runners over the field and the hoppers either jump in or try to jump over, in which case they strike the banner and fall back into the oil. A mere touch of the oil is certain death; it may take half a minute if the insect falls directly into it, or it may take half an hour if the insect simply alights on the banner moistened with the oil, but no matter whether the insect dies immediately or takes a little time, he is sure to die eventually. The great majority of the hoppers that jump into the pan, jump out again at once but they die just as certainly and almost as quickly as if they remained.



Fig. 56.—Red-legged locust (After Riley.)

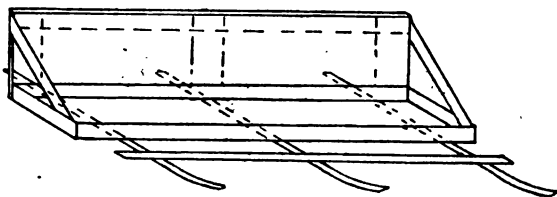


Fig. 57.—Hopperdozer. Author's illustration.

Cut-worms.

Just about the time that the danger from crows has abated somewhat, the young sweet-corn is often called upon to withstand an attack by cut-worms. There are striped cut-worms, dark, light, glassy, greasy and many other sorts, each belonging to a different species, and each developing into its corresponding moth. The moths or millers are nocturnal in their habits, and are spoken of as owlet-moths because of their habits and the shape of their heads.

Cut-worms naturally work on sod land, and for this reason, it is well to avoid planting corn, tobacco, tomatoes, or anything else especially liable to their attacks directly after grass. Then too, the great majority of our cut-worms pass the winter in a partially grown condition, and when spring comes, and the sod and roots are replaced by a comparatively smaller number of corn plants, the worms are hardly to be blamed for feeding on them. Sod land, then, has its disadvantages when used before a crop liable to attack by cut-worms. It is also a menace when adjacent to a corn-field, for the "worms" will travel quite a distance from their breeding grounds in order to get at their favorite food. They work at night, traveling on the surface of the soil, and cutting off the plants low down at or just below the soil level. They cut off much more than they can use and then retire before daybreak, burrowing lightly and hiding often near the plant just cut off. One "worm" will forage night after night and destroy many times as much food as could be eaten. One can not help wondering at its wasteful habits. It has been suggested that the food is cut in order to let it wilt before it is eaten. Wet food does not seem to agree with some caterpillars, neither does that which is too vigorous and turgid. It is not unreasonable to suppose that much of the food is cut in order that it may wilt and be ready for

future use, rather than from mere wanton destructiveness. As has been stated many of the cut-worms pass the winter in a partially grown condition, just beneath the surface of the soil. Occasionally, in winter, during a sudden thaw, the larvae will crawl up on top of the snow, being driven upward by the water from the melting ice and snow. In such cases they seldom get back into winter quarters, but perish as soon as it freezes again. The writer has seen the snow thickly dotted with cut-worms on such occasions, both here and in Minnesota. Many parasites feed on them and shrews and birds devour quantities.



Fig. 58.—Cut worms. Larva, adult, and pupa in earthen cell. From Saunder's *Insects Injurious to Fruits*.

REMEDIES.

The one measure that has been most successful in the past, is the use of poisoned baits, when the trouble is on a large scale. On a very small scale, other methods are more effective. Of the baits used, clover is the favorite. A goodly pile of clover should be cut, and while it is still fresh and green, it should be wet down with paris-green and water, using about half a pound of poison to a barrel of water, then, late in the afternoon, so that it will keep fresh as long as possible, twist bunches of this wetted clover in wads, more or less compact, and throw out over the field at short intervals. If the field to be protected be near a field in sod, then place an extra amount on the threatened side. The cut-worms love clover and oftentimes they will hide under such wads of fresh green food in the morning after a night's travel, eating a little of the poisoned food before hiding away. Poisoned pieces of turnip will do if clover is not to be had.

Poisoned bran, sweetened with a little molasses and made into moist balls the size of a plum, has been recommended, and Mr. Sirrene, of the New York State Experiment Station, recommends dry bran mixed with dry paris-green, sowed on the surface of the soil by means of a hand drill. In any case do not use such baits of bran unless stock and poultry are excluded or when partridge and quail are likely to get it, and do not expect to find the dead worms in the morning unless you are willing to sift the top soil for some distance about each bait, for the pests always bury themselves before dying. The only way to judge of the death of the larvae is by the cessation of their work.

In the garden, when tomatoes, cucumbers, etc., are attacked, they may be protected by placing a collar of stiff, smooth paper about the plant. Make a collar about two inches high and two inches in diameter, and set in about the plant, keeping it in place with a little dirt scraped up against it. Cut-worms do not climb well, and almost never touch



Fig. 59.—Tomato plant with collar of stiff paper for cut worms. Original.

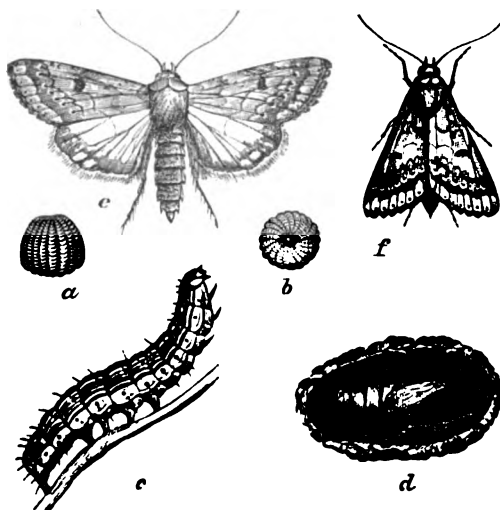


Fig. 60.—Boll-worm or corn ear-worm. (After Riley, Third Mo. Rep.)

a plant so protected. In the melon and cucumber fields, use berry boxes without the bottoms. They may be purchased cheaply in knock-down form.

Several species of cut-worms have the habit of climbing, and are spoken of as climbing cut-worms. They work on the buds of fruit trees early in the spring. For a discussion of these pests see Special Bulletin No. 24 of this station.

INSECTS AFFECTING THE CORN IN THE COB.

Corn Ear-worm or Cotton Boll-worm (*Heliothis obscura*).

Next to cut-worms, in point of importance to sweet-corn, comes the corn ear-worm, known also as the tomato-fruit-worm and in the South as the boll-worm. When our corn is "in the milk" one often finds, work-

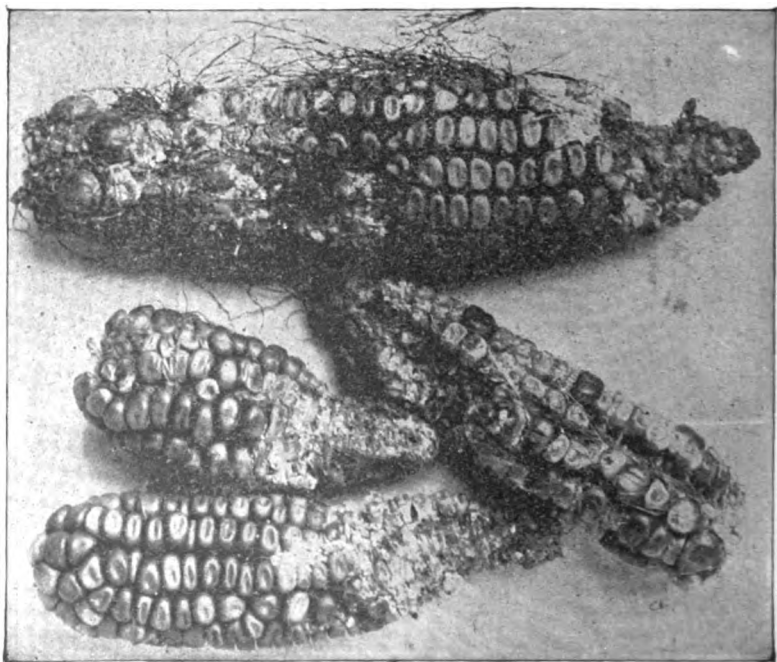


Fig. 61.—Work of corn-ear worm. From J. B. Smith, State Exp. Station of New Jersey.

ing either in the silk or in the soft kernels inside the ear, one or more almost hairless caterpillars or "worms" which tunnel about, destroying part of the juicy kernels, and leaving a disgusting, blackened furrow that ruins the entire ear for the market. When the corn becomes too hard for food, or where there are too many larvae in one ear, they eat one another. When full grown they are striped longitudinally and may be greenish or reddish in color and about one and one-fourth inches long. The pupal stage is passed underground, the moth that comes from the pupa, being dull, dirty-yellowish in color with a darker band just inside the border of the hind-wings.

REMEDIES.

As the insect passes the winter in the soil, it is possible to destroy some of them by late fall or early spring plowing, either burying them so deeply that they never get out, or exposing them to their natural enemies. This practice should be carried on over a wide area, however, if much benefit is to be received; for the adults can fly with ease from one farm to another.

Fall Army-worm (*Laphygma frugiperda*).

A close relative of the army-worm, but one sometimes exhibiting quite different habits, is the fall army-worm. The larva of this pest is about one and one-half inches long, striped longitudinally, with numerous raised, black points, from each of which springs a black hair. The head is marked with a V-shaped mark. There are several generations each year, the last one doing the most injury. Unlike the regular army-worm, this insect does not move in well organized bodies, but each larva migrates in its own way. In the northern part of this State, the writer has seen these caterpillars working in the ears of corn, very much as do the larvae of the boll-worm or corn-ear worm. One or more caterpillars tunnel in the green kernels while it is "in the milk." Here they render the sweet-corn unfit for market by eating out a portion of the kernels and soiling the rest in the vicinity of their tunnels.

REMEDIES.

Fall plowing is the only really sensible remedy. The greater part of these pests that live over winter, do so in the larval stage in the soil, and fall plowing destroys many of them while they are in their earthen cells.

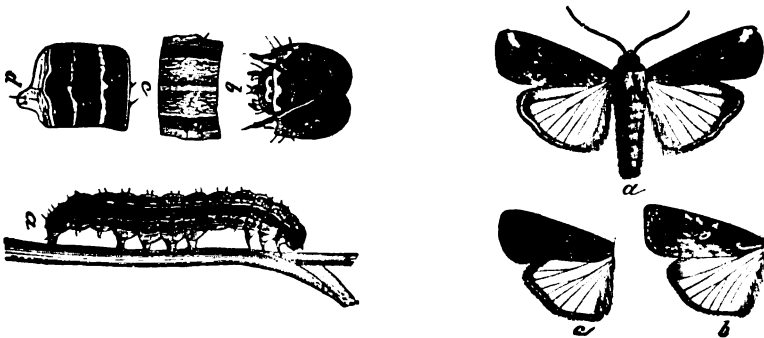


Fig. 62.—Fall army-worm, larva and adult, showing details. After Prof. Lawrence Bruner.

Bumble Flower-beetle (*Euphoria inda*).

This is a thick-set, awkward beetle of dull-yellow and brown color. It resembles somewhat the June-beetle in its habits, but unlike that well known insect this beetle does all its injury to crops in the adult condition. It attacks fruits and corn in September and October, making its way into the ears of corn, and feeding on the soft, pulpy kernels when they are in the milk. A few years ago, before evaporators came into use, and when it was customary to dry corn in the sun, this beetle

was troublesome because of its habit of feeding on the drying corn. There is no remedy known other than hand-picking, but fortunately, the beetles are comparatively few in number, and do not, as a rule, execute so much harm as they threaten.

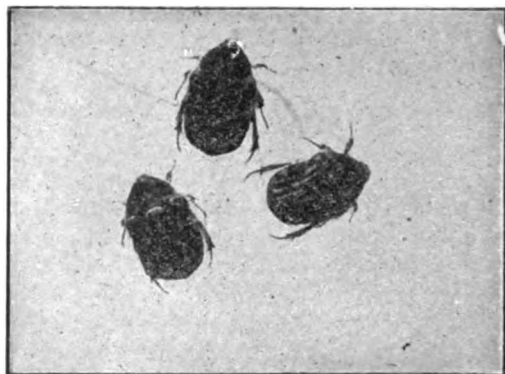


Fig. 63.—Bumble flower-beetle, Author's illustration.

INSECTS AFFECTING THE TOMATO.

INSECTS AFFECTING THE STEMS.

Tomato-borer (*Papaipama nitela*).

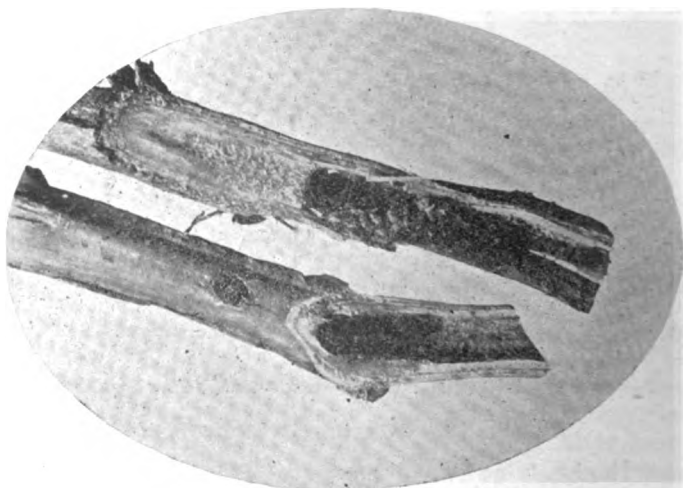


Fig. 64.—Work of tomato-borer in stalk of plant, slightly enlarged. Original.

For several years, complaints have come in of a borer that attacks potatoes, tomatoes and flowering plants, notably dahlias. The insect is found also in rhubarb, rag-weed, cockle-bur and corn. When the tunnel is cut open and the larva taken out, it is found to be about an inch

in length, flesh-colored, with four longitudinal brown stripes extending from the head to the anal extremity. When ready to change to the pupal form, the larva deserts the tunnel that it has made and buries itself in the soil. After a time the adult emerges, as this takes place in the fall, it is likely that the adults hide away and hibernate in that form. There is reason to suppose that there is one generation each year.

REMEDIAL.

The life-history of this pest seems to reveal no weak points where a spray can be made to avail. The fact that it works on many of our common weeds indicates that clean culture over wide areas, will cut down the supply materially. Other than this we shall have to depend on cutting out the larvae, keeping close watch for wilting plants and examining all such systematically and regularly.

INSECTS AFFECTING THE FRUIT.

Corn Ear-worm or Tomato Fruit-worm (*Heliothus obscura*) (see Insects affecting Sweet-corn).

INSECTS AFFECTING THE FOLIAGE.

Tomato-worm or Tobacco-worm (*Phlegatontius sexta*).

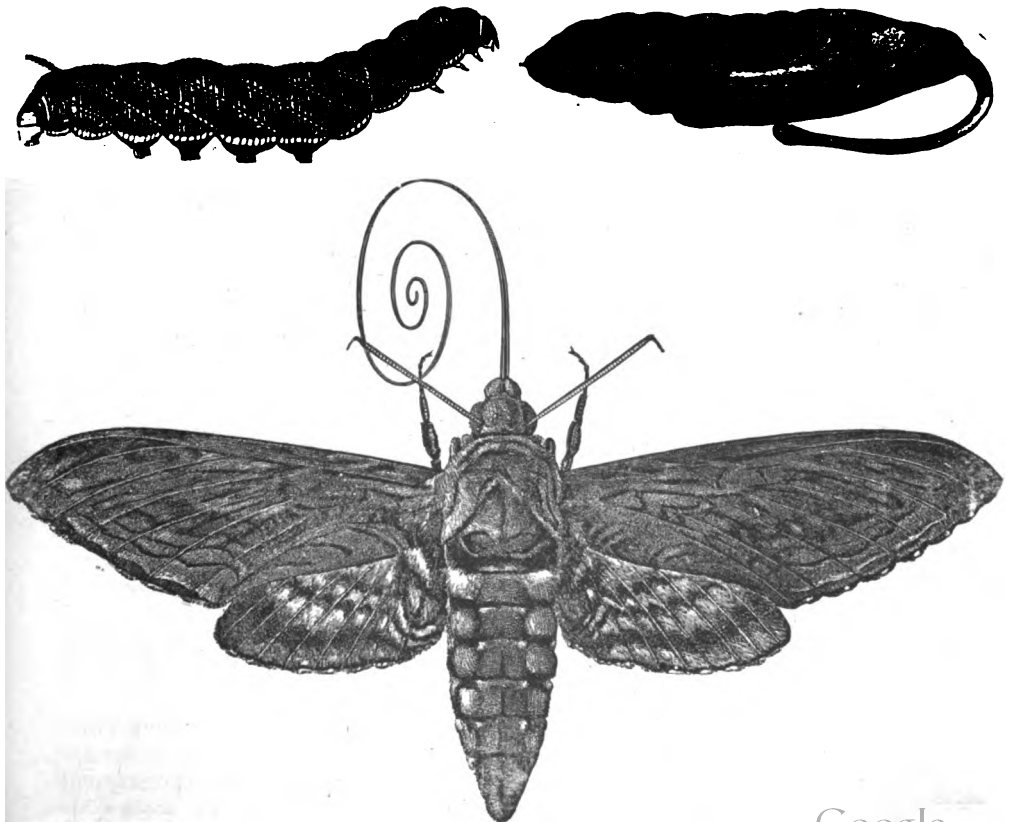


Fig. 65.—Tomato-worm or tobacco-worm, larva, pupa and adult. (After Walsh and Riley, Am. En

The larval stage of this insect is known as the tobacco-worm or the tomato-worm, depending on the host on which it happens to be feeding at the time. It is a naked, green caterpillar of large size and is feared because of the prominent curved spine at the posterior extremity. It is also found commonly on the potato. When full grown, it sometimes measures three inches in length. The pupal stage is passed in the soil. The pupa is remarkable for the jug-handle form shown in the figure. From this pupa comes the adult moth which is grey in general color, and is one of the hawk-moths or humming-bird moths so common about petunias, etc., at dusk.

REMEDIES.

This caterpillar is so conspicuous and its work so easily detected that there is usually little trouble in hand-picking. Paris-green will kill many of them in time but poison works slowly on these large insects and a good deal is required to kill them so that it is best to expedite matters by hand-picking. Then, too, paris-green is not safe on tomatoes after the fruit is well started.

DIRECTIONS FOR PREPARING INSECTICIDES.

Most insects may be classified either as chewing insects or as sucking insects. Beetles, grasshoppers, etc., chew their food, while bugs suck theirs by means of long piercing beaks with which they penetrate inside to the juicy parts of the plants. Moths and butterflies suck their food, when in the adult condition, but chew it when in the larval state. Now chewing insects, in many cases, eat foliage, fruit, etc., and if this food be treated with a coating of some arsenical poison, they get the poison in the ordinary course of events, and die. Many chewing insects, like some of the borers, are protected in their burrows and never eat at the surface of the plant except possibly, when just entering the plant.

Sucking insects are not affected by poisons of this nature, as they draw their supply of food from beneath the surface. With them it is necessary to use some substance like kerosene-emulsion, which kills by contact, but does not injure the plant. Special contact insecticides have been found to work well against special insects and at certain definite times, therefore the best results are obtained by using a variety of killing agents, each suited to a particular purpose.

While it is necessary to spray evenly and thoroughly with an arsenical poison, like paris-green, it is easily seen that the utmost care is required to obtain good results with a contact insecticide. Most beetles and caterpillars wander about more or less and some of them will find the poison themselves, on the other hand, each insect must be hit by a contact insecticide to be killed.

As everyone knows, the arsenical poisons are the cheapest when effective, and when nothing prohibits their use. Vegetables well advanced or those which ripen quickly, should not be sprayed with permanent poisons like paris-green. Hellebore has the advantage of losing its

strength after a time, and may sometimes be used when paris-green would not do.

Now a word about applying the spray. In general use a nozzle that will produce a fine spray, one that will stick in minute particles to the plant and which will not go on in drops. Always stop spraying before the plant commences to drip. Paris green, and all the arsenites, remain in suspension in the water if properly prepared, and are not dissolved. These small particles of poison will settle to the lowest part of a drop of water, and remain on the plant as the water evaporates, if the drop be of small size. If, on the other hand, the drops are large enough or numerous enough to run together and drip off, most of the poison drips off first, leaving very little to dry down on the plant. It is therefore desirable to have the water evaporate as quickly as possible. This is best brought about in dry, sunshiny weather. Such weather is best for kerosene-emulsion also, because the oil is apt to injure the foliage if left on too long before evaporating. Therefore choose dry, sunshiny weather for spraying if possible.

CONTACT INSECTICIDES, FOR INSECTS THAT SUCK.

KEROSENE-EMULSION.

Place two gallons of ordinary kerosene in a warm place, either in a warm room or in the sun, and allow it to become as warm as possible without danger from fire. Boil one pound of laundry or whale-oil soap in a gallon of soft water until completely dissolved. Remove the soap solution from the fire, and while still boiling hot, add the kerosene and agitate for ten minutes, or until the oil is emulsified, with a spraying pump by forcing the liquid back into the vessel from which it was pumped. When the liquid is perfectly emulsified it will appear creamy in color and will flow evenly down the side of the vessel when allowed to do so. Care should be taken to completely emulsify the oil and this is accomplished much more easily when the mixture is hot. This strong emulsion may now be readily diluted with water and used, or it may be stored away for future use. When cold it becomes like sour milk in appearance and should be dissolved in three or four times its bulk of hot water before diluting with cold water. If the water is at all hard, "break" it by adding a little salsoda before putting in the soap.

Small amounts of this emulsion may be made by using the ingredients in small quantities but in the same relative proportion.

WHALE-OIL SOAP KEROSENE-EMULSION.

This is made with whale-oil soap in place of the common laundry soap. It is superior to the plain emulsion in some ways.

PYRETHRO WHALE-OIL SOAP KEROSENE-EMULSION.

To one gallon of the undiluted emulsion made with whale-oil soap, add one ounce of Pyrethrum. Stir well and dilute before applying.

WHALE-OIL SOAP.

This remedy has the advantage of being ready made, requiring no preparation other than that of dissolving. It may be used in winter or summer. In winter it should be put on warm. It costs from three and one-half to five cents per pound when purchased in quantity. For a winter spray, against the San Jose scale, or any other scale, it should be put on at the rate of two pounds to a gallon of water. Each part of the tree should be wetted by the liquid, and the work should be done toward spring if possible, but before the buds commence to swell. It sometimes kills the fruit buds of peach and plum, especially is this true if the spraying be done in the early or middle part of the winter.

A summer spray, against plant-lice, etc., is prepared by dissolving one pound of the soap in from four to six gallons of water, and applying as in the case of kerosene-emulsion.

INSECT POWDER, BUHACH, PYRETHRUM.

This valuable remedy has one drawback, its cost. It is too expensive for use on a large scale. It kills insects through their breathing pores, but is harmless to man and beast. It will kill many of the insects of the garden if dusted on or mixed with water in the proportion of one ounce to two gallons of water.

Use the powder when it is undesirable to use poisons, but never buy any unless it comes in tightly sealed packages. It loses its strength on short exposure to the air. An hour will suffice to weaken it. It must be applied from time to time as it quickly loses its strength.

TOBACCO.

Tobacco, in the form of dust, may be obtained of the large manufacturers at the rate of from one and one-half to two cents a pound. It is useful in destroying root-lice, especially woolly aphis, in young trees, and in keeping insects from garden truck. It should be worked into the ground liberally for root-aphis.

An infusion, or tea, made from waste, will kill plant-lice if sprayed on when they first appear. Steep in sufficient water to cover the waste stems and dilute until the color is that of strong tea.

DRY-SLAKED LIME.

Finely slaked lime is often useful because of its slight caustic properties. Against such larvæ of saw-flies and beetles as are sticky, for instance those of the cherry-slug and asparagus beetle, it may be used as a substitute for poison, if the latter, for some reason, is undesirable.

Stone lime may be slaked with a small amount of hot water, using just enough to turn it to a dry powder. Such slaked lime is as fine as flour and very soft to the touch having very little grit. Use a metal pail or kettle to slake in as the heat will set fire to wood. Do not use too much water, and where possible use freshly burned lime.

CARBOLIC-ACID EMULSION.

Hard soap, one pound, or soft soap, one quart.

Water (boiling) one gallon.

Crude carbolic-acid, one pint.

The soap is to be dissolved in the water and while it is still boiling

hot the acid is added and the whole churned by forcing the stream from the nozzle into the kettle, just as is done in making kerosene-emulsion. Dilute with thirty times its bulk of water and apply. If any injury results from the use of this emulsion, dilute it still more. Use the *crude* carbolic-acid in making the emulsion as it is very much cheaper and just as good.

STOMACH POISONS, FOR INSECTS THAT CHEW.

PARIS-GREEN AND LIME.

Always use lime with paris-green, it makes the poison stick better, beside greatly reducing the danger of burning the foliage.

For spraying from a barrel, the writer has found the following method very useful.—Place from one-quarter to one-half pound of good quick lime or unslaked lime, in each of three or four tin pails which will hold about three quarts or less. Old cans or crocks will answer just as well. Add enough hot water to slake it into a thin cream or paste. Now add to each lot, one-quarter pound of paris-green, previously weighed out, and placed in paper bags, stir while the lime is hot and allow to stand for some time. Now measure out about forty-four gallons of water in your spraying barrel and make a mark that will show you how high it comes in the barrel, add the contents of one tin pail (viz., one-quarter pound of paris-green and one-half pound of quick-lime slaked) into the forty-four gallons of water in the barrel. Stir well and spray. The pails or crocks can be used one at a time and refilled occasionally so that the stock is always on hand ready for use. Keep the pails or crocks for this purpose alone.

KEDZIE MIXTURE (ARSENICAL).

This mixture, originated by the late Dr. R. C. Kedzie, of this station, is cheap, but it has the disadvantage of lacking a warning color. It is a good substitute for paris-green, but must be made with care, and stored in well labeled jugs.

Dr. Kedzie in giving directions for its preparation says: "Dissolve the arsenic by boiling with carbonate of soda, and thus insure complete solution; which solution can be kept ready to make a spraying solution whenever needed. To make the material for eight hundred gallons of spraying mixture, boil two pounds of white arsenic with eight pounds of sal-soda (crystals of carbonate of soda—'washing soda'—found in every grocery and drug-shop) in two gallons of water. Boil these materials in any iron pot not used for other purposes. Boil for fifteen minutes or until the arsenic dissolves, leaving only a small muddy sediment. Put this solution into a two gallon jug and label 'Poison,' stock material for spraying mixture."

"The spraying mixture can be prepared whenever required, and in the quantity needed at the time by slaking two pounds of lime, adding this to forty gallons of water; pour into this a pint of the stock arsenic solution. Mix by stirring thoroughly and the spraying mixture is ready

for use. The arsenic in this mixture is equivalent to four ounces of paris-green."

"The pot, jug, etc., must never be used for any other purpose after using it for making this mixture."

If an additional pound or two of lime be added to the mixture it will help to make the application permanent and conspicuous without in any way interfering with its effects. In using it the extra lime should be added.

WHITE ARSENIC AND LIME.

White arsenic is much cheaper than paris-green and just as effective. The work of preparation is of course to be considered but the real reason why the writer hesitates to recommend its use is because of the similarity in appearance between arsenic, baking-powder, flour, etc.

It may be prepared in the following manner:—In two gallons of water, place two pounds of freshly slaked lime and one pound of arsenic. Boil from one-half to three-fourths of an hour. By this time the arsenic will have dissolved and united with the lime. When wanted for spraying, dilute with water and lime. The above pound of arsenic will suffice for four hundred gallons of water. In order to prevent the "burning" of the foliage, slake one pound of lime to every twenty gallons of water used for diluting. The above is for apple trees. Potatoes will stand the spray considerably stronger.

ARSENATE OF LEAD.

This poison, although not in general use throughout the country, has several advantages; it shows where it has been applied; it is light and does not require such vigorous stirring as paris-green; and it does not easily burn the foliage. To prepare it, dissolve four ounces of arsenate of soda, and eleven ounces of acetate of lead, each in a gallon of water. On mixing the two solutions together we shall get a milky precipitate, which should be stirred into 100 gallons of water. It is now ready for spraying. Of course, larger or smaller quantities may be made in the same proportion, and if this preparation does not seem strong enough, it may be applied much stronger with safety.

Its action is slower than that of paris-green, but the fact that it does not readily burn the foliage is an advantage when spraying various kinds of delicate trees with one mixture.

HELLEBORE.

White hellebore is the powdered root of a plant. It kills both by contact and as an internal poison. It may be applied either dry or in the form of a liquid. When used dry it should be mixed with three or four times its weight of flour or plaster and then dusted on the insects. Applied wet, one pound should be mixed with twenty-five gallons of water and this liquid applied as a spray. A convenient form of duster is made as follows: A tin box like a pepper-box, holding a quart or less, is fastened to a stick about six feet long by means of a screw running through the bottom of the box into the stick. The cover of this box should be finely perforated to allow the poison to come out very slowly

when shaken. This box can then be shaken over the infested plants and the insects peppered or dusted with the poison.

Hellebore is especially useful against all moist-bodied insects, such as currant-worms, pear and cherry slugs, etc., for the poison sticks to their bodies.

BORDEAUX MIXTURE.

Copper sulphate, crystals (Blue vitriol)...	4 pounds
Fresh lime (unslaked).....	6 pounds
Water	40 gallons

Dissolve the copper sulphate in a wooden pail of water, by suspending it in a coarse cloth near the surface of the water. In this way it will dissolve much more quickly than if allowed to settle to the bottom. Use wood as the copper will deposit out on metal thus weakening the solution.

Slake the lime, with hot water if possible, in any case if only a small quantity is to be used. Dilute the copper sulphate to twenty gallons in one barrel, and dilute the lime to twenty gallons in another, then dip alternately from each of these barrels into the spraying barrel, stirring the mixture all the time.

If large amounts are to be made, it is often expedient to make a stock solution of the copper sulphate using one pound to a gallon of water, then when ready to mix, dilute four gallons of the stock solution in place of four pounds of the crystals. The required amount of lime may be ascertained by slaking six pounds in a metal pail and noting just how full it fills the pail. The same amount may be measured each time from a stock of *freshly slaked* lime and diluted to twenty gallons before mixing. Larger and smaller amounts may be made in the same proportion.

TREATMENT FOR INSECTS IN STORED GRAINS AND SEEDS.

The treatment for dried grains containing insects is comparatively easy, providing the grain or seeds is in tight bins or barrels, capable of being tightly and quickly closed. Old carpets, blankets, etc., often will be found useful in helping to make the bins tight.

Measure the inside of the bin, counting in the air space above the grain, if the bin is not entirely full, and place some old pans or plates on top of the grain. Then for every cubic foot of space in the bin, put a dram of liquid carbon bisulphide in the pans and quickly close the bin. Thus a pound of the liquid will suffice for about one hundred cubic feet of space or a little more, or for about one hundred bushels of grain.

If the seed or grain is more than two or three feet deep in the bin, the liquid should be poured into it at some depth in order to insure its spreading evenly and filling all the space treated. This is easily done with a piece of gas-pipe fitted with a wooden stick for its entire length. The pipe with the stick in place is thrust down half way to the bottom of the bin, the stick withdrawn and the liquid poured down through the pipe. The stick merely prevents the pipe from becoming filled when

thrust into place. The bin should remain tightly closed for from twenty-four to forty-eight hours, a longer exposure is likely to injure the germinative power in some seeds.

The liquid carbon bisulphide, on being liberated, will be quickly transformed into a gas, which being heavier than the air, settles to the bottom and fills all the air spaces between the seeds or kernels. The liquid costs about thirty cents for a single pound, or five pounds for a dollar. The work must be done in the day time, away from lamps, stoves or fire of any sort. No fire must be allowed to come near until everything has been thoroughly aired for the gas or fumes are very explosive when mixed with air. Grain should be shoveled over several times. Great care must be observed to breathe as little as possible of the fumes as they are very poisonous and will as easily produce death among men as among insects.

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231 Suggestions Concerning Legume Inoculation.
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BULLETIN 234.

FEBRUARY, 1906.

MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT

FEEDING DAIRY COWS

BY

C. D. SMITH.

AGRICULTURAL COLLEGE, MICHIGAN

1906.

MICHIGAN

STATE AGRICULTURAL COLLEGE

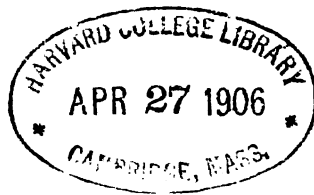
EXPERIMENT STATION

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Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.

SUCCOTASH AS A SOILING CROP.

R. S. SHAW.

There may be some question as to the propriety with which the term succotash is used if the meaning, derived from its origin, is taken into consideration. This word was first applied to a dish used by the North American Indians, consisting of green corn and beans variously compounded. In recent years, however, agricultural and live stock experimenters have applied this term quite frequently to soiling crops consisting of mixtures containing corn, some legume, such as peas or beans and one or more cereals.

In the production of succotash crops numerous mixtures have been tried in different parts of the country with greatly varied success. The data hereafter given was secured in an endeavor to produce some satisfactory forage crop rotations for swine, designed to cover the greatest possible portion of the year. The first mixture, grown in 1903, consisted of corn, peas, oats and barley; though this combination produced a large tonnage of green food it made but one crop in the season, as all of the plants in the mixture failed to make a second growth after having been cut or grazed off. With the object of securing a second growth, in the season of 1904 the mixture was changed to the following, viz: corn, peas, oats, rape and millet. This combination was successful in producing a second crop of rape and millet when the first crop was cut with the scythe, but not when closely grazed off. Within eight weeks from the time of the first cutting this second crop was nearly knee high, but was mostly rape as the millet could not keep pace with it in growth. The success thus achieved in securing a second crop of rape and millet created the desire to combine some leguminous plant with the rape in place of the millet. As a result the four sowings of the spring of 1905 were made up as follows, viz.: corn, peas, oats, rape and clover. On two of these plantings the first crop was so heavy and badly lodged that the clover and rape did not succeed in making a second crop large enough to pay for pasture, but rallied sufficiently to make a good stand late in the fall. The other two sowings formed a thick mat consisting of both clover and rape by October 1st. The object now is to determine whether the rape and clover can be grazed moderately close in the fall and then secure a clover crop for soiling purposes the following spring, thus securing three crops from the one sowing. As it will require two or three seasons more experimenting to secure data relative to the last object sought it was thought best to report on the present progress of the work.

VALUE OF SUCCOTASH.

There is now no question in the mind of the writer but that the 1905 succotash mixture consisting of corn, peas, oats, rape and clover is an extremely useful combination and that it can be produced as regularly

and successfully as any other crop or mixture if properly handled. It is especially valuable as a soiling crop for dairy cows because of the fact that it fills in a gap between the possible use of green clover and green corn. We have also found it highly satisfactory for young calves being housed during the heat of the summer. Though the first attempt was to use this mixture as a forage crop for swine it has not proved to be so valuable for that purpose as was expected. (By forage crops we mean those grazed off and by soiling crops those cut while green, hauled off the land and fed elsewhere.) When the succotash was grazed off by swine the losses were heavy from the trampling and wallowing of the animals, in fact so much so that it had to be hurdled off giving them access to but a limited area every few days and this is a somewhat expensive and troublesome method. (See illustration on cover.) When cut, hauled and fed in the hog lots or pens there was little or no loss. When the rape and clover plants were bitten off close to the ground by hogs many of them failed to grow again; when cut higher with a scythe they did not fail to grow. Succotash may be objected to for the dairy cow because of the large amount of water it contains, but it nevertheless furnishes the succulence so necessary to supplement her ration while on dry and exhausted pastures. This food was used for the college dairy herd during the season of 1905 between the time the silage was exhausted and green corn became available. The composition of succotash does not vary greatly from that of green corn in the earlier stages, when used for soiling purposes. The question naturally arises, would it not be better practice to supplement the failing pastures with silage rather than succotash? We should answer yes, providing one has the silage, but at the present time all dairymen are not possessed of silos and most of those in use are generally empty long before midsummer. Should succotash be grown for such emergencies and not needed it can be cut and cured for hay when the oats are in the milk or dough stage. The small amount of rape in the first cutting has not tainted the milk so far as used.

The second growth of rape and clover must needs be less of a certainty than the first crop of the original mixture, as favorable conditions for growth usually diminish as the season advances, owing to greater heat and lack of moisture. A lodged crop cannot remain in that condition long without injuring the clover and rape; for their benefit the crop should be cut as quickly as possible. If succotash is grown to any great extent for soiling purposes it should be sown at two or three different dates, the first late in April or early in May, the others following at intervals of ten days or two weeks. From the different dates of seeding some one or more of the lots is almost sure to produce a second growth suited for sheep or swine pasture and probably for some other classes of live stock also. The ability to secure a crop of clover on the same ground the next season, for pasture or soiling, is at present uncertain but is well worth trying for.

CONDITIONS SUITED TO THE GROWTH OF SUCCOTASH.

The ground upon which this crop is grown must be rich. We do not believe large tonnages can be secured from poor land except in unusual seasons when the rainfall is large and favorably distributed. It is not

a difficult matter to properly enrich sufficient ground for the crop of succotash. A small area only is necessary, say from one to three acres, to tide the average dairyman over from clover to corn on a failing pasturage. Manure cannot well be used to better advantage than on this area. We have found that the manure for this crop should not be buried too deep, for the crop should be induced to start and grow quickly; it is short lived. Our best results have come from spreading a good coating of heavy manure (not strawy) on the land after plowing and before fitting for seeding; this manure is not allowed to lie on the surface of the ground but is worked into and incorporated with the top two or three inches of soil by means of the disk and harrow. This plan almost insures a quick and vigorous start of the small seeds such as clover and rape. After the seed bed has been thoroughly prepared, sow a good seeding of rape and clover mixed, broadcasting it and then follow with the seed drill burying the mixture of corn, peas and oats at the proper depth; the drill will cover the small seeds previously sown on the surface. In general the grain mixture should be sown at the rate of about two bushels per acre.

SUCCOTASH MAY VARY IN COMPOSITION.

Though the seeds of the various species of the mixture may be sown in definite proportions, at each seeding of the season, still, we should expect the relative numbers of plants of each to vary somewhat with peculiarities of climatic conditions, and the same results must be expected to follow as regards the relative development of the different sorts. This is illustrated quite markedly by a comparison of illustrations Nos. 3 and 4.

RAINFALL.

In this publication attention is directed to the amount of rainfall during the growing periods of the several crops produced. This is done because of the fact that the seasons of 1903 and 1905 were extremely unusual in their large precipitation. Up to a certain degree the rainfall may effect yields favorably and beyond that may become injurious. For purposes of comparison we give the average rainfall for four of the summer months during the five years preceding 1903, as follows: May 3.39 in., June 3.8 in., July 3.91 in., and August 1.93 in.

SUCCOTASH.

Report of first year, 1903.

This consisted of a one-third acre lot, one of several of the same area used to produce forage crops for swine. For several years preceding the date given these lots were used for hog runs. One-half of each lot is high land and somewhat heavy, sloping sharply toward the Cedar river; the lower ends of the lots are quite light and sandy and are usually submerged annually by the spring floods. Owing to the trampling received while wet the soil of these lots had been puddled and was not in the best physical or mechanical condition to grow good crops the first season.

This crop was sown on May 8th, 1903. The mixture consisted of corn 1 peck, peas 1 peck, oats 1 peck and barley 6 quarts, and was sown by an ordinary grain drill at the rate of $2\frac{1}{2}$ bushels per acre. This crop was not pastured off by hogs as intended, owing to inability to finish the necessary fencing before the succotash got too large to pasture. The cutting of this crop began June 24th, forty-seven days from the date of sowing and was completed twelve days later, viz.: July 6th. It was removed as fast as consumed by some pigs in pens. The entire yield of this green crop from the one-third acre was 7629. pounds, the weighing was done immediately after cutting. At this rate the yield per acre would have been 22,887. pounds or 11.44 tons. This yield appears phenomenal, but the ground was exceedingly rich and the rainfall during the fifty-nine days was unusual, amounting in all to 9.48 inches distributed as follows: May 8th to June 1st 2.5 in., month of June 6.28 in., and July 1st to 6th .7 in. The growth was exceedingly dense and tall; all the grain showed well except the corn which was apparently from poor seed. The greatest objection to this mixture was found in the fact that it did not contain plants of a sort capable of making a second growth after cutting.

Report of second year, 1904.

As in the case of the first sowing in 1903, part of this crop was grown on a one-third acre lot set aside for growing forage for hogs, but one which had grown a heavy crop of rape the previous year. Another lot of one-half acre was grown in field No. 5. The mixture used differed somewhat from the first one, consisting of corn, peas, oats, rape and millet sown in the following manner. After the ground had been prepared for seeding, a mixture of rape and millet, equal parts, was sown broadcast on the land by hand, using a pint of each to the one-third acre; the corn, oats and peas in equal parts by measure, were then mixed and sown by an ordinary grain drill at the usual depth, the same operation covering the rape and millet lightly. This seeding was made May 7th, 1904. All the plants of the mixture made a good even start except the millet which grew slowly, but some soon outdistanced the others. Illustration No. 1 shows the relative size and proportions in which the five kinds of plants grew in the mixture. The plants were secured by cutting out two or three small areas, representative of the lot, and then separating out the plants of the various sorts which were photographed for this illustration. The samples were taken July 12th, at which time the entire crop averaged three feet in height, but many of the pea vines were much longer than this. This lot of succotash was foraged off by sixteen young pigs weighing 1208 pounds, turned in on June 20th, 44 days from the date of sowing, and removed July 22nd, 32 days later. The pigs received some supplementary food. The illustration on the cover shows some pigs foraging on the 1904 crop. The picture was taken about July 1st. In this picture can be seen the hurdles used in restricting the pigs from foraging on but a limited area. The lower edge of the top boards of these panels is just three feet above ground. This one-third acre of succotash was completely foraged off seventy-six days from

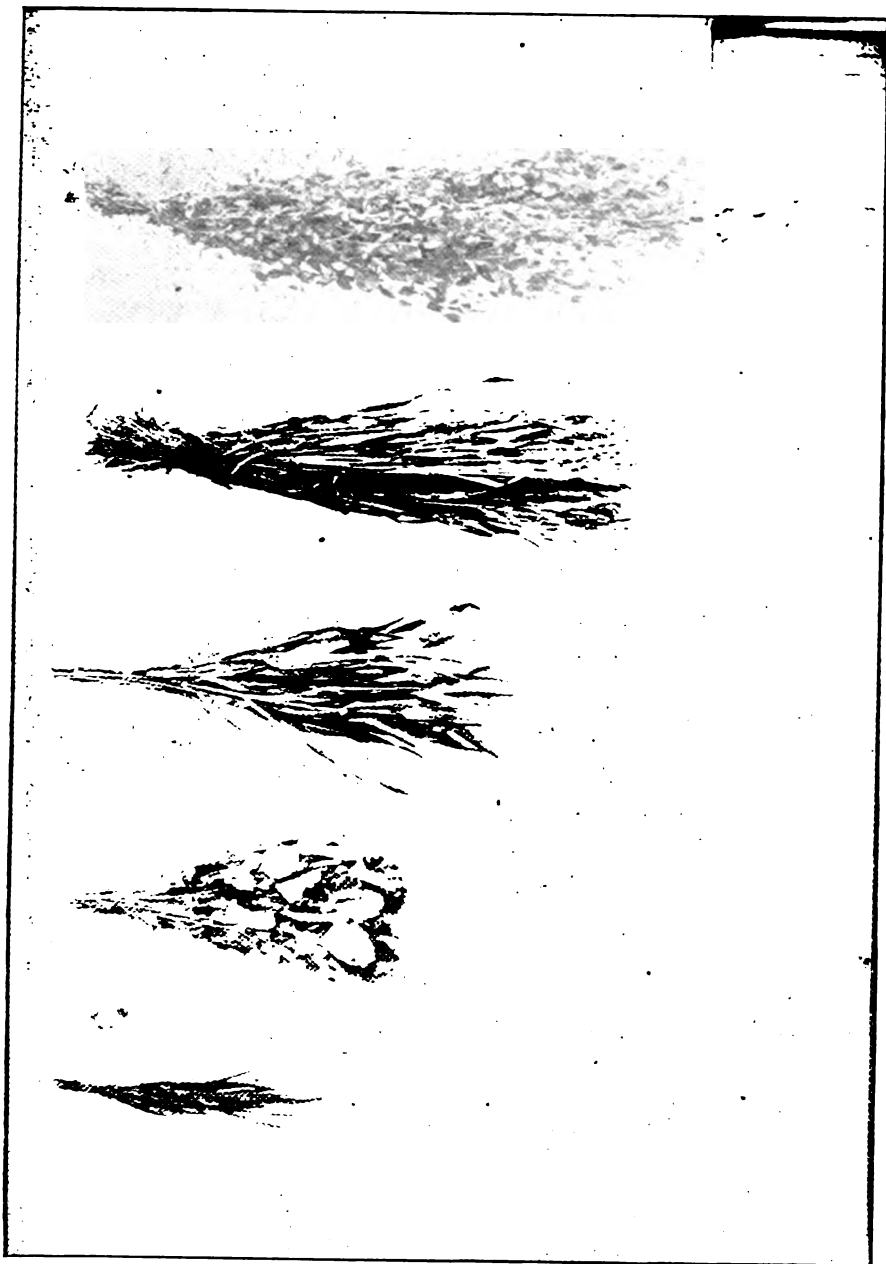


ILLUSTRATION NO 1.

Millet.	Rape.	Corn.	Oats.	Peas.
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the date of sowing, May 7th. During this time the entire rainfall was 6.86 in., distributed as follows: May 7th to June 1st, 2.4 in., the month of June 2.49 in., and between July 1st and 22nd 1.97 in. The precipitation of this year, seemed to be sufficient for the satisfactory growth and best use of the crop. In both '03 and '05 the great excess of rainfall is believed to have been detrimental. The succotash grown in field No. 5 this season was cut and fed to the dairy herd, but no record of the yield was made. The second growth of rape and millet was good.

The following is the result of the analysis of the 1904 succotash mixture with the results expressed on "air dry" samples, by F. W. Robinson, Station Chemist.

No. B-632.

Moisture	8.30%
Ash	10.35%
Protein (total Nitrogenous).....	15.09%
Proteids (true)	14.30%
Amido bodies	0.79%
Ether extract	5.45%
Crude Fiber	27.01%
Carbohydrates not fiber	33.80%

Report of third year, 1905. (First sowing.)

This year one acre of succotash in addition to the one-third acre in the forage rotation for hogs was grown in field No. 5, which has been set off to the use of forage, root and soiling crops on a larger scale. This field comprises both high and low land; the high land is quite a good substantial loam but the low land is quite sandy; every acre strip contains some of both kinds of soil. The acre referred to produced a root crop in 1904. It was not plowed before being sown to succotash but was given a moderate top dressing of heavy manure after which it was disked and harrowed to form a seed bed. The succotash mixture used in this instance was similar to that of the previous year except that clover was put in the place of the millet. On May 1st a portion of this area was sown to corn, oats, peas, rape and clover, and the balance was left and sowed on May 20th. On June 6th an almost unprecedented flood occurred completely submerging the succotash on the low land, the water covering it for several days and entirely destroying it. Illustration No. 2 shows the stage of development of these two sowings on June 8th, the first one being about a foot in height. On June 20th that portion of the area drowned out was resown thus giving three dates of sowing. As these plantings were made with a view to furnishing green food for dairy cows they were all cut, hauled off the ground and fed in the stables. That portion of the sowing of May 1st on the high land, not drowned out, consisted of .164 acre or a fraction less than 1-6th of an acre. The crop was cut between July 10th and 17th beginning 70 days from the date of sowing. By this time the oats had lodged badly and made a second stooling. the sprouts from which were several inches high. Fully half the peas were in the cooking stage though blossoms were present on the ends of the

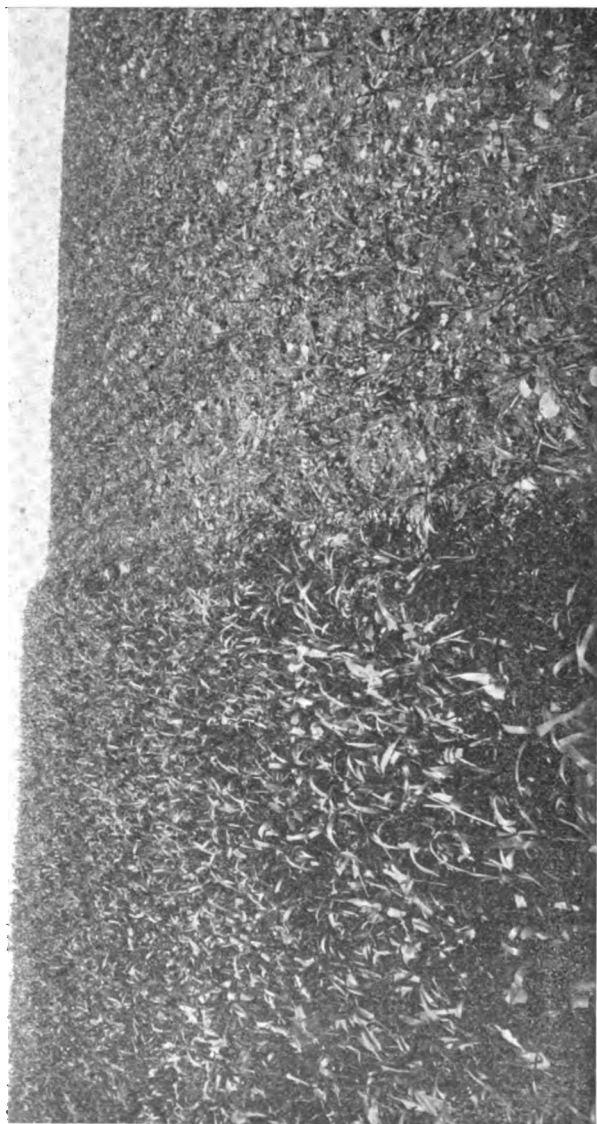


ILLUSTRATION NO. II.
Succotash.—Photographed June 8th, 1905

Sown May 20th, 1905.

Sown May 1st, 1905

vines caused, undoubtedly, by the excessive rainfall; the oats had been headed out fully ten days. Before cutting samples were taken from four representative areas each two feet square; the plants of each species were separated into groups, weighed, photographed and turned over to the chemist for analysis. The number of plants of each species on these sixteen square feet was as follows, oats 61, peas 68, rape 55, and corn 22, and their weights were, oats 10.6 lbs., peas 4.2 lbs., rape 2.75 lbs., and corn .5 lbs. Illustration No. 3 shows this sample.

The total weight of succotash cut from this area of .164 acre was 3991.5 lbs., equivalent to 12.16 tons per acre. The crop would have been cut and fed earlier had it not been for the exceedingly wet weather. The clover did not make sufficient growth by the time of this cutting to be included in the crop. The later growth of the clover was seriously impeded by the smothering of the lodged crop but the heavy rainfall following on the other hand was favorable to it. By October 1st the clover and rape plants were a foot high. During this period of growth extending from May 1st to July 17th, seventy-seven days, the total rainfall was 17.29 in. distributed as follows, May 5.17 in., June 7.47 in., and July 1st to 17th 4.65 in. This is nearly double the average rainfall for these three months.

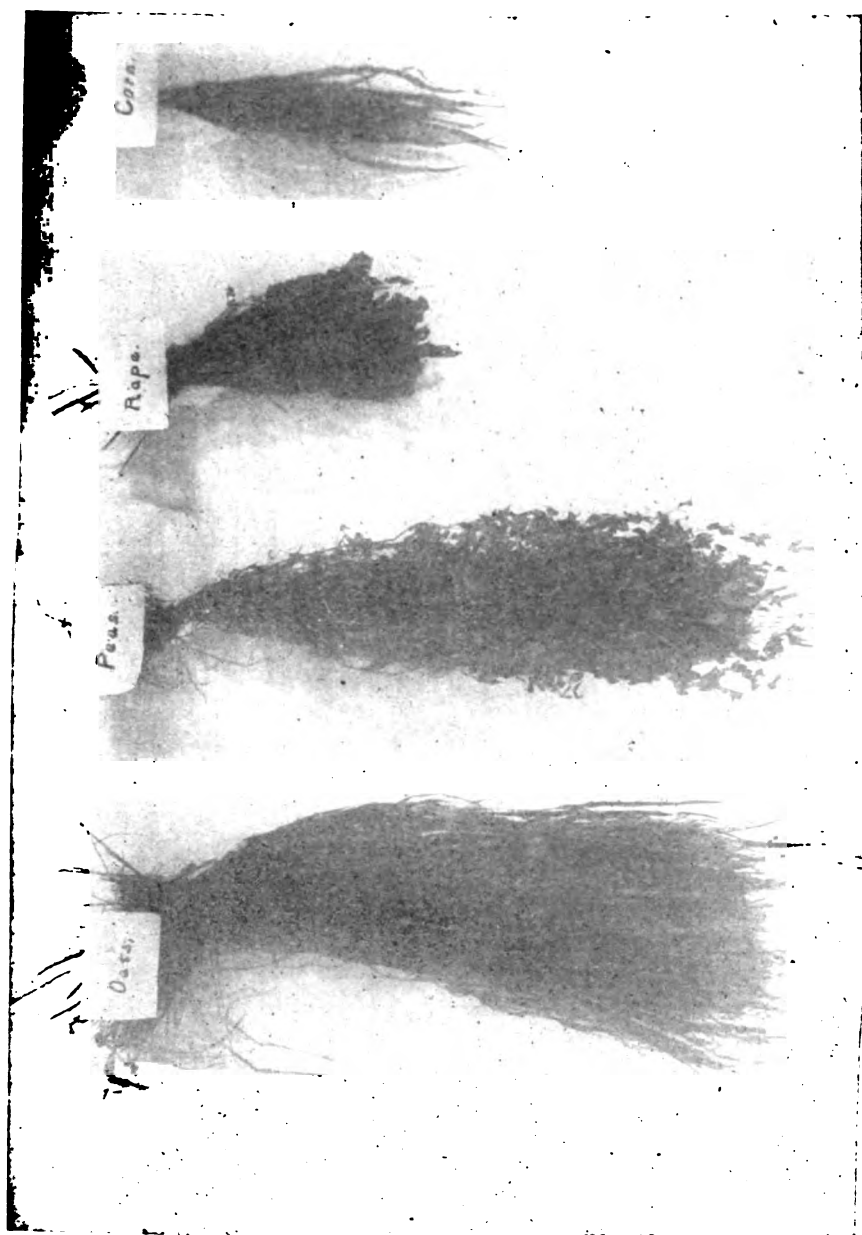
The analyses of the 1905 samples were furnished by Mr. A. J. Patten, Station Chemist. The following is the result from the analysis of the samples from the first seeding of this year:

	Air Dry Basis.	Fresh Basis.
Moisture	7.85%	89.90%
Ash	8.78	0.96
Total protein	11.94	1.31
Ether extract	2.70	0.30
Crude fiber	32.27	3.54
Nitrogen, free extract.....	36.46	3.99

Report of second sowing, third year, 1905.

This, the second part of the 1905 crop, was sown under the conditions already described, on May 20th, on ground planted to roots in 1904, top dressed in April, 1905, and then fitted for seeding with disk and harrow without plowing. The lower portion of this seeding was destroyed by the early June flood but the uninjured part on the highland comprised .32 of an acre, or a trifle less than one-third. On July 27th samples were taken from four representative areas including 16 sq. ft. From this area the following numbers of plants were secured, viz.: corn 74, peas 82, oats 43 and rape 10; the weights of these groups of plants on this date were corn 6.9 lbs., peas 1.7 lbs., oats 4.3 lbs. and rape 3 lbs. Later developments showed a greater number of rape plants many of which were too small to be included in the sample.

The cutting of this second sowing began July 22nd, sixty-two days from the date of sowing and was completed August 11th. The total amount of green food removed was 8285 lbs. from the .32 ac. At this rate the yield would be 12.62 tons per acre. The relative development



SUCCOTASH.—ILLUSTRATION NO. III.

of the various species in this sample is shown in illustration 4.

The total rainfall during this period of eighty-three days was 16.38 in. distributed as follows, from May 20th to June 1st 1.94 in., June 7.47 in. July 5.75 in. and August 1st to 11th 1.22 in.

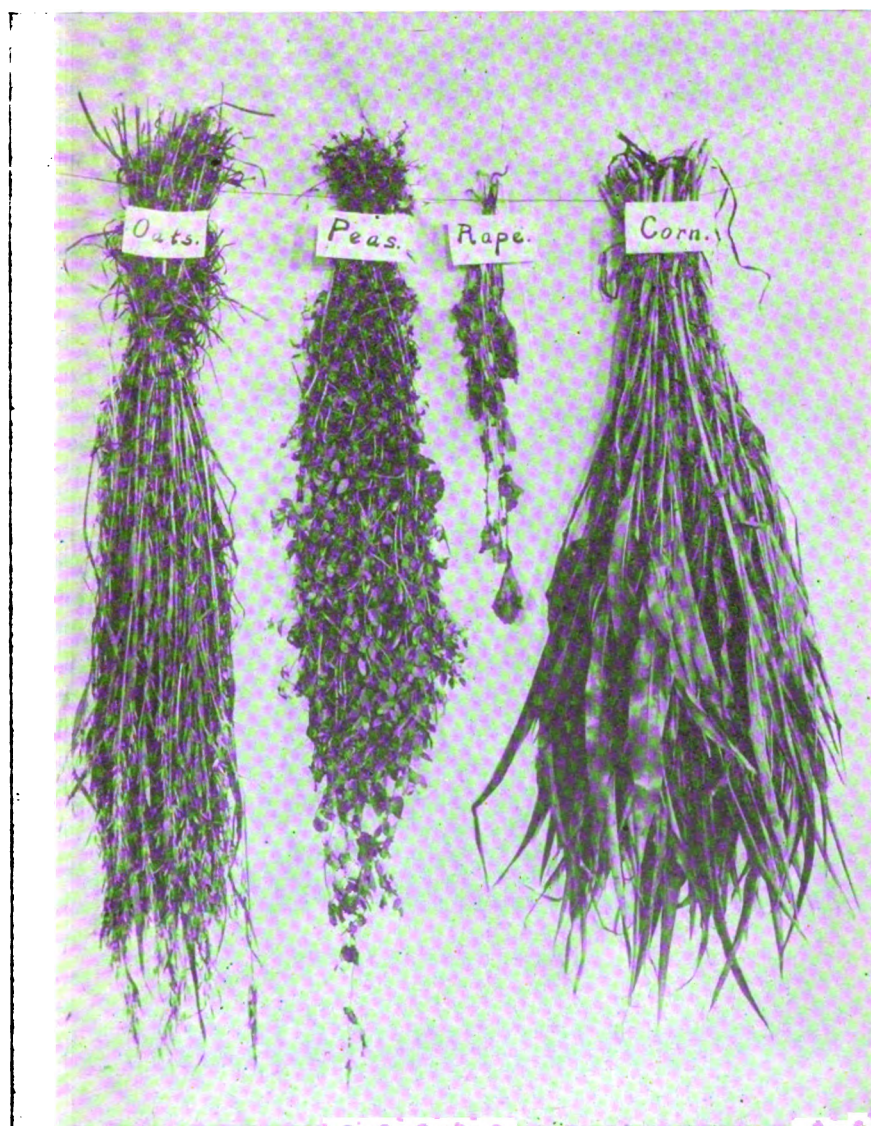
The following is the result of analysis of the sample from the second sowing of 1905:

	Air Dry Basis.	Fresh Basis.
Moisture	9.73%	84.80%
Ash	9.24	1.55
Total protein	10.09	1.70
(True proteids	6.85	1.15)
(Amido bodies	3.24	0.55)
Ether extract	3.00	0.50
Crude fibre	30.68	5.17
Nitrogen free extract.....	37.26	6.28

Report of third sowing third year, 1905.

As heretofore stated the lower portions of the first two seedings of 1905 were destroyed by flood. As the river was a long time reaching its normal level this low land remained somewhat wet and soggy until late in the season. It was June 20th before this ground could be fitted and sown but notwithstanding the late date of seeding, the soggy condition of the ground, and its sandy character, the growth was rapid and the yield fairly large. This area comprised .537 of an acre or a fraction over one-half. The cutting began August 16th, fifty-seven days after planting, and was finished August 31st, yielding 8033 lbs. of green food; at this rate the yield per acre was 7.47 tons. In this case the oat straw rusted quite badly but no bad effects were noticed on other plants of the mixture. The total rainfall during the growth of this cutting was 9.99 in.

The green food secured from these three sowings was used for three different purposes. A part was fed to dairy cows to supplement short pastures in the absence of silage; a part was fed to calves of both beef and dairy types confined in the stables during the greatest heat of summer and fly time; the balance was fed to hogs confined in pens. In every case the results were satisfactory.



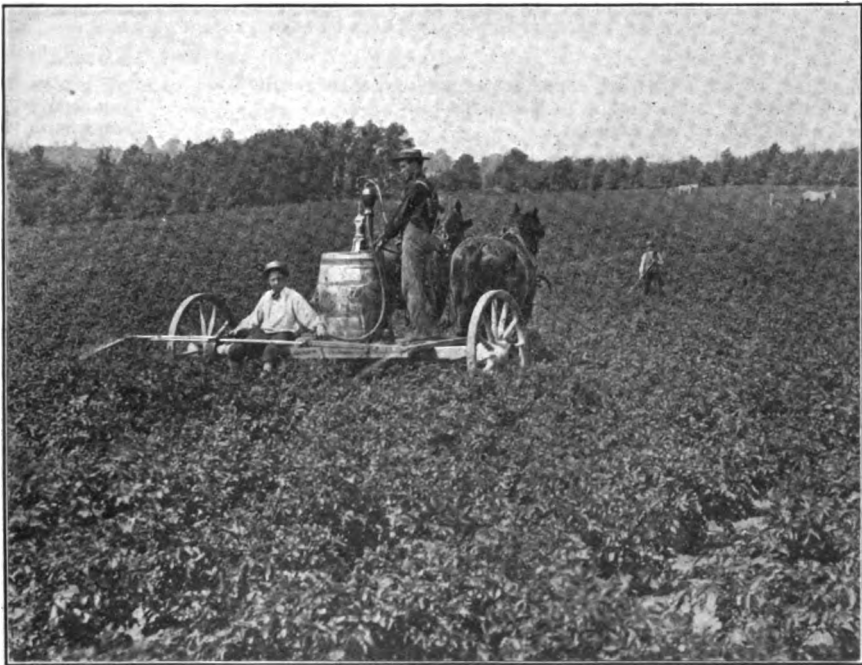
SUCCOTASH.—ILLUSTRATION NO. IV.

BULLETIN 236.

APRIL, 1906.

MICHIGAN
STATE AGRICULTURAL COLLEGE
EXPERIMENT STATION

DIVISION OF HORTICULTURE



A HOME MADE POTATO SPRAYER.

SPRAYING FOR POTATO BLIGHT IN 1905

BY C. A. McCUE.

AGRICULTURAL COLLEGE, MICHIGAN,
1906

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Grayling, Crawford County, 80 acres deeded.
 South Haven, Van Buren County, 10 acres rented; 5 acres deeded
 Chatham, Alger County, 160 acres deeded.

MAY 21 1905

The Station

SPRAYING FOR POTATO BLIGHT IN 1905.

BY C. A. M'CUE.

For several seasons the potato growers of Michigan have suffered serious losses in their potato crops through the devastation wrought by late blight (*Phytophthora infestans*). The disease was particularly bad during the last season and the loss to growers of the State ran up into thousands of dollars.

The disease is prevalent in nearly all, if not all, parts of the State where late potatoes are grown. The history of the disease in other states seems to indicate that the trouble is here to stay and that we may look for it in every favorable season. It has been known for nearly two score years that spraying with Bordeaux mixture would prevent the blight to a greater or less extent, but it has been only within the last few years that the knowledge of this fact has been applied to commercial potato growing; and then only in a few localities. The practice is by no means common. In Michigan it is hard to find a grower who systematically sprays his potatoes for blight every year. The reason for this is not that the grower is careless and neglects the crop, but rather that he is ignorant of the cause of the trouble and is at a loss to know what to do to stop it. In the correspondence carried on by the author with a large number (100) of potato growers in the State it was astonishing to find the large number of growers who did not even know what Bordeaux mixture was; and the majority of them believed the blight to be incurable. The reasons why potato spraying has not been more generally practiced in the State might be stated as follows:

1. The grower is ignorant of the cause of the disease.
2. He is not aware that there is anything that will prevent it.
3. He does not believe that the results obtained would pay for the time and trouble of spraying.

The growers should be set right on these questions as far as possible: hence the mission of this bulletin. No new facts will be found in these pages, but an endeavor will be made to present the cause and the prevention of potato blight to potato growers of the state for their consideration.

I. THE CAUSE OF THE BLIGHT.

Late blight is caused by a fungous disease that works upon the tops of the potato plant and which also causes rotting of the tubers.

The disease is very energetic and spreads with great rapidity, sometimes ruining a crop within a few days. It usually makes its presence known soon after the 15th of August in this state and thrives

best when the temperature is about 70° F. and the air is full of moisture. It is worse in wet than in dry seasons and the general opinion is that it causes more rotting of the tubers in clayey than in sandy soils. The fact that the disease flourishes best in wet seasons has caused many farmers to believe that "blight is caused by wet weather". This is true in part, in that the wet weather furnishes the ideal conditions for the rapid development of the fungous; but the real cause is the presence of the disease upon the plant when the wet weather comes along. We can have wet weather without having blight; and, vice versa, we can have blight without having wet weather. The two are not inseparable.

The disease usually appears on the lower leaves of the plant in the form of a yellowish-brown spot that rapidly turns brown and dies. The trouble rapidly spreads upon the plant until soon nothing green remains to be seen but the extreme top leaves. These too, soon succumb and the whole top dies and rots. If we examine one of these yellowish-brown spots on the leaves, early in the morning when the dew is on, we shall probably find a white mildew-like substance on the lower side of the leaf. If this is examined with a microscope it will be found to consist of a large number of egg-like spore-bodies on minute stalks projecting out of the leaf tissue. (See Fig. I.) These spores which correspond to seeds, soon fall off the parent stalk and either fall to the ground or are blown to a neighboring plant. If the spore finds lodgment on a potato leaf, and if moisture is present, it starts to germinate and sends out a slender, thread-like branch (mycelium). It is believed that this mycelium has no power in itself to penetrate the tissues of the leaf, so it grows on until it reaches some opening into the leaf. This opening may be one of the numerous breathing pores, (stomata), of the leaf, or it may be a hole made by some insect. On reaching such an opening the little branch enters and pushes its way between the cell walls of the leaf robbing them of their nourishments. Once in the plant this mycelium grows very rapidly, branching again and again and finally penetrating every part of the plant tissues, robbing them of their juices and causing them to decay. Occasionally a branch of the mycelium comes to the surface and sends out many fruiting stalks that bear myriads of new spores. These mature, fall off, and go on their mission of destruction.

If the spore falls to the ground and rains follow, it may be washed downward through the soil until it finds lodgment upon the tuber. Here it finds warmth and moisture and begins to grow, sending its mycelium into the tuber, robbing it of its starch, breaking down its tissues and causing rot. Here its action may or may not be rapid: the spore may sprout, enter the tuber, and make only a slow growth, not manifesting itself until the potato is dug and stored, or perhaps not until the tuber has been planted for the next crop. So the disease may be passed on from generation to generation of potatoes by means of infected seed potatoes.

We have seen that the disease passes a greater part of its life history within the plant tissues where it is safe from harm. To fight it successfully it must be attacked at some time when it comes to the surface, during the spore stage, or when the spore is germinating. So we see that any remedy used must be a preventive one.

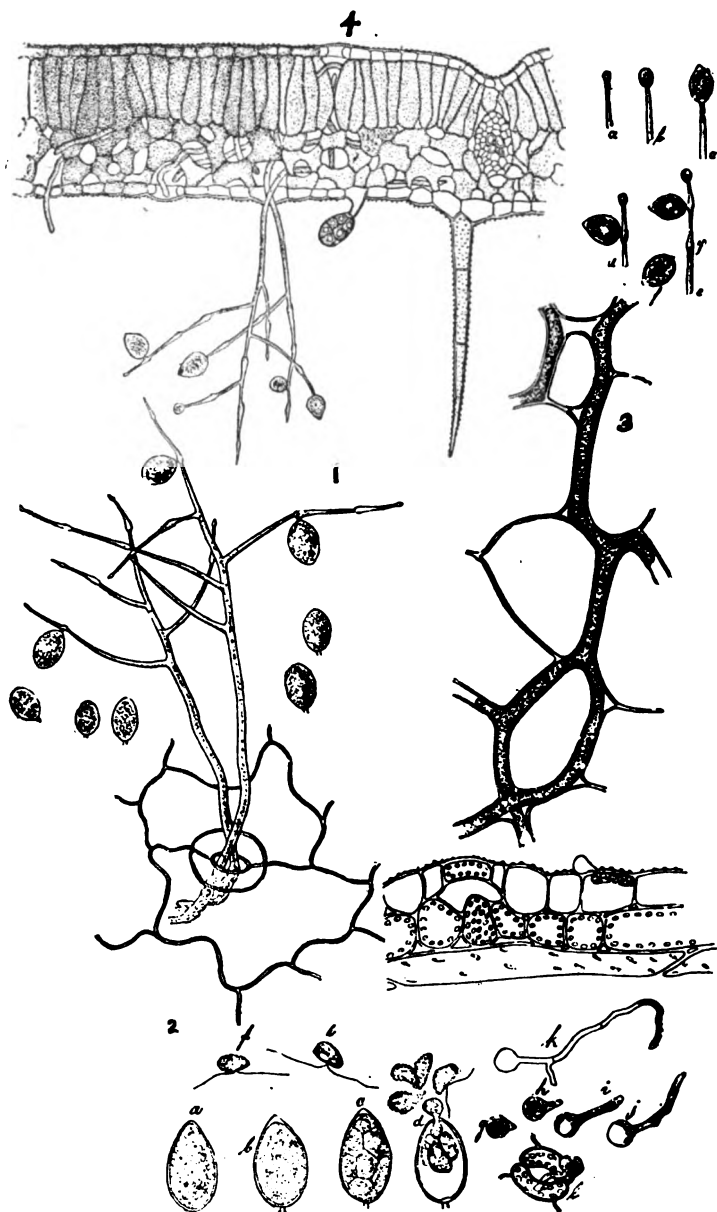


FIG. 1. THE FUNGUS OF THE LATE BLIGHT OF THE POTATO.

Phytophthora Infestans.

(After U. S. Dept. of Agr.)

1. Spore stalks showing spores falling off.
2. Spore cases bursting and spores germinating.
3. The mycelium passing between the cells of the leaf.
4. Section of Potato leaf showing the first bearing stage of the fungus appearing on the under side of the leaf.

II. EXPERIMENT AT THE COLLEGE IN 1905.

In the spring about 10 bushels of Rural New Yorker Potatoes were procured. These were badly infected by scab (*Oospora scabies*), and in many cases nearly the entire starch content of the tuber had been exhausted by the parasite. The potatoes were treated with Formalin for 90 minutes and planted. The ground selected was a flat, low piece of ground where an old plum orchard had been pulled out in the spring and the land was unsuitable for potatoes. The tubers were planted on the 16th of June in rows 3 feet apart and the seed 15 inches apart in the row. Owing to the late planting, the unsuitable soil and the devitalized condition of the seed the plants were nearly two weeks in appearing above the ground and at first only a feeble growth was made and the outlook was very poor for any kind of a crop.

The field was divided into sections of six rows each.

Rows 1-6 were to be sprayed every four days with Bordeaux mixture.

Rows 7-12 were to be sprayed every 4 days with the milk of lime alone, at the rate of 4 pounds of stone lime to 50 gallons of water.

Rows 13-18 were to be sprayed every 10 days with Bordeaux mixture.

Rows 19-24 were to be sprayed every 15 days with Bordeaux mixture.

Rows 25-30 were to be sprayed every 20 days with Bordeaux mixture.

Rows 31-34 were to be sprayed every 14 days with Paris green at the rate of 1 pound to 75 gallons of water.

Rows 35-41 were to be left unsprayed as a check.

The plan outlined was carried out to the letter. The first spraying on every plot was given on the 22d of July. The Bordeaux mixture used was composed of 4 pounds Copper Sulphate, 4 pounds Lime and 50 gallons of water.

When the tops were thoroughly dead the different plots were dug. The four center rows only of each section were used in computing results in order that there might be no overlapping of spraying material. The tubers on each plot were graded into merchantable and small, and carefully weighed.

The table below shows the relative time of dying of the tops and digging of the different plots.

TABLE NO. 1.

<i>Manner of Treatment.</i>	<i>Pronounced dead.</i>	<i>Dug.</i>
Unsprayed	Sept. 13	Sept. 23
Sprayed with Bordeaux every 20 days.....	" 26	" 30
Sprayed with Bordeaux every 15 days.....	" 29	" 30
Sprayed with Bordeaux every 10 days.....	" 29	" 30
Sprayed with Bordeaux every 4 days.....	Oct. 4	Oct. 7
Sprayed with Lime every 4 days.....	Sept. 17	Sept. 23

The blight was first noticed on the unsprayed rows about August 10th, and was very conspicuous by the 15th. The 6 rows sprayed with Bordeaux every 4 days were but very little affected by the blight.

On digging the different plots a great difference in the yield was noted. The results were computed for an acre in each case and the cost of spraying was also kept. There was no need of spraying with an arsenite for bugs as only a few old ones were found on the vines, and they were picked off by hand in order that absolutely pure data might be obtained for each plot.

The following tables give the results obtained:

TABLE NO. 2.

Unsprayed.

Yield per acre of merchantable tubers.....	41 bu.
Yield per acre of small tubers.....	23 bu.
Total yield per acre	64 bu.
Gross receipts at 50 cents per bushel at time of digging.....	\$20 50

TABLE NO. 3.

Sprayed with Lime Water Every Four Days.

Yield per acre of merchantable tubers.....	52.5 bu.
Yield per acre of small tubers.....	26 bu.
Total yield per acre.....	78.5 bu.
Gross receipts per acre at 50 cents per bu.....	\$26 25
Gross gain in dollars per acre by spraying.....	5 75
Increase in yield by spraying.....	11.5 bu.
Number of times sprayed.....	14
Total amount of lime used per acre.....	42 lbs.
Cost of material	\$0 19
Cost of application	7 42
Total cost of spraying per acre.....	\$7 61
Net loss per acre	1 76

In the above table we see that while an increased yield was obtained it was more than offset by the cost of application. In order to make a profit the yield would have to be increased about 15 bushels of merchantable potatoes per acre.

TABLE NO. 4.

Sprayed with Bordeaux Mixture Every Twenty Days.

Yield per acre of merchantable tubers.....	68.8 bu.
Yield per acre of small tubers.....	15 bu.
Total yield per acre.....	83.8 bu.
Gross receipts per acre at 50 cents per bu.....	\$34 40
Gross gain in dollars per acre by spraying.....	13 90
Increase in yield per acre by spraying.....	27.8 bu.
Number of sprayings	4
Amount of lime used per acre.....	12 lbs.
Amount of copper sulphate used per acre.....	10 lbs.
Cost of lime per acre.....	\$0 05
Cost of copper sulphate per acre.....	70
Cost of application	2 12
Total cost per acre of spraying.....	\$2 87
Net gain per acre by spraying.....	11 03

TABLE NO. 5.

Sprayed with Bordeaux Mixture Every Fifteen Days.

Yield per acre of merchantable tubers.....	73.5 bu.
Yield per acre of small tubers.....	15.8 bu.
Total yield per acre.....	89.3 bu.
Gross receipts per acre at 50 cents per bu.....	\$36 75
Gross gain in dollars per acre by spraying.....	16 25
Increase in yield per acre by spraying.....	32.5 bu.
Number of sprayings	4
Amount of lime used per acre.....	12 lbs.
Amount of copper sulphate used per acre.....	10 lbs.
Cost of lime	\$0 05
Cost of copper sulphate	70
Cost of application	2 12
Total cost per acre of spraying.....	\$2 87
Net gain per acre.....	13 38

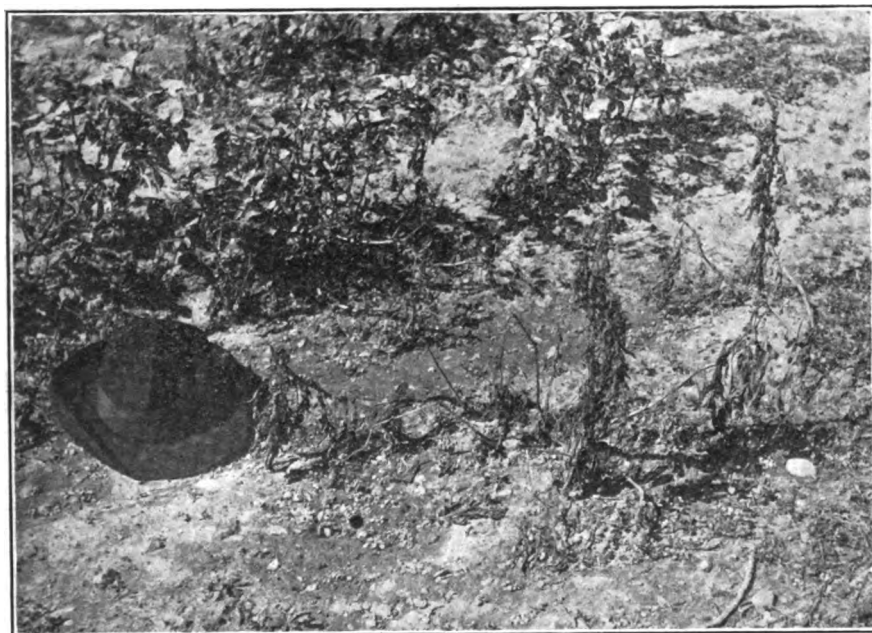


FIG. 2. The hill on right unsprayed: The hill on the left sprayed every 4 days with Bordeaux mixture. Photo taken Sept. 23, 1905.—Photo by Fletcher.

TABLE NO. 6.

Sprayed with Bordeaux Mixture Every Ten Days.

Yield per acre of merchantable tubers.....	80.5 bu.
Yield per acre of small tubers.....	19.2 bu.
Total yield per acre.....	100.7 bu.
Gross receipts per acre at 50 cents per bu.....	\$40 25
Gross gain in dollars per acre by spraying.....	19 75
Increase in yield per acre by spraying.....	39.5 bu.
Number of sprayings	6
Total amount of lime used per acre.....	18 lbs.
Total amount of copper sulphate used per acre.....	15 lbs.
Cost of lime per acre.....	\$0 08
Cost of copper sulphate per acre.....	1 05
Cost of application	3 18
Total cost of spraying per acre.....	\$4 31
Net gain per acre	15 44

TABLE NO. 7.

Sprayed with Bordeaux Mixture Every Four Days.

Yield per acre of merchantable tubers.....	81½ bu.
Yield per acre of small tubers.....	21½ bu.
Total yield per acre.....	103 bu.
Gross returns per acre at 50 cents per bushel.....	\$40 75
Gross gain in dollars per acre by spraying.....	20 25
Increase in yield per acre by spraying.....	40.5 bu.
Number of sprayings	14
Total amount of lime used per acre.....	42 lbs.
Total amount of copper sulphate used per acre.....	35 lbs.
Cost of lime per acre.....	\$0 19
Cost of copper sulphate per acre.....	2 45
Cost of application	7 42
Total cost of spraying per acre.....	\$10 06
Net gain per acre	10 19

According to the works of Millardet and Gayon,* the copper in Bordeaux mixture does not become soluble until the Hydrate of lime is changed to the Carbonate of lime, this process taking about ten days. In the above table it will be noticed that fresh Bordeaux mixture was applied every four days, thus keeping the copper in an insoluble form. The results go to show that it is not at all necessary for the copper to be in solution in order to kill the spores and check the growth of Blight (*Phytophthora infestans*).

From the preceding tables it appears that the most profitable results were obtained from those sprayed every 10 days with Bordeaux mixture or 6 times during the season (See Table No. 6).

The lime experiment (See Table No. 3) is interesting from the fact that it shows that the mere presence of some foreign substance on the foliage helps very markedly in retarding the growth of the disease. Further investigation along this line will be carried on during the coming season.

The condensed results of the experiment are fully shown in the table below.

*Millardet et Gayon, La bouillie bordelaise Celeste, Jour. d'Agr prat 54e Ann. T. I, No. 8, Feb. 20, 1890, p. 272.

TABLE NO. 8.

Condensed Results of Potato Spraying in 1905.

Manner of spraying.	Gain in yield per acre.	Gross gain in dollars per acre.	Net gain in dollars per acre.	Cost per acre.	No of sprayings.	Crop insured for.
With Bordeaux every 4 days. . .	40.5 bu.	20.25	11.90	10.19	14	1 year.
With Bordeaux every 10 days. . .	39.5 bu.	19.75	15.44	4.31	6	3.5 years.
With Bordeaux every 15 days. . .	32.5 bu.	16.25	13.38	2.87	4	4.7 years.
With Bordeaux every 20 days. . .	27.8 bu.	13.90	11.03	2.87	4	3.8 years.
With Lime every 4 days.	11.5 bu.	5.75	Loss 1.76	7.61	14	.....

Cost per acre per application, 72 cents.

SPRAYING AN INSURANCE.

The last column of the above table shows how long it would be possible to spray an acre of potatoes upon the profits of this year's spraying and protect them against any possibility of blight, if there should be no blight during that time; or, in brief, in the case of the acre sprayed every ten days with Bordeaux mixture, enough profit was made to pay for spraying an acre of potatoes six times for three years and three times on the fourth year without extra cost.

The cost of 72 cents per application per acre is unusually large and would easily be less in large field operations. The writer believes that on areas of two acres or over the work could easily be done at a total outlay per application per acre of not over 55 cents.

III. RESULTS OBTAINED BY MR. W. A. SWAN, OTSEGO.

In reply to questions sent out in a circular letter to potato growers by this Department, Mr. W. A. Swan of Otsego answered the question, "Have you ever sprayed with Bordeaux Mixture for the blight?" by saying, "Yes, for the last five years, two years with a four-row sprayer." The next question asked was, "If so, has it paid you? Give figures if possible. Will you spray next year?" Mr. Swan answered, "Yes, last year (1904) my crop averaged 200 bushels per acre; 2 acres were sprayed six times and averaged 330 bushels per acre. This year I sprayed 27 acres; the average was 128 bushels.

One acre through the center of the field was not sprayed and gave 109 bushels.

Two acres on one side sprayed three times gave 124 bushels per acre.

Two acres on the other side sprayed four times gave 147 bushels per acre.

I figure my total gain this year at 700 bushels, at a cost in spraying of \$70.00. I will keep on spraying.

Cost of spraying 27 acres:

450 lbs. Copper Sulphate.....	\$30 50
2 bbls. Lime	2 00
Man 9 days (also board).....	18 00
Horse 9 days	9 00
20 per cent interest on sprayer.....	10 00
Total	\$69 50

Average cost per acre for single spraying about 45c to 50c. Our 9-acre field, planted May 20, was sprayed six times in the rainy season and the mixture was washed off every other day, no chance, in fact this field died early, September 20. The yield was 140 bushels."

The above statement of Mr. Swan goes to show that spraying for late blight is a sound business proposition.

IV. RESULTS OBTAINED IN OTHER STATES.

One of the first field experiments in spraying potatoes for late blight was made by Jones of the Vermont Experiment Station in 1889. Spraying experiments for blight at that Station have been kept up for a great many years and the results have always been the same; i. e., that it pays. Some of the results obtained in Vermont, picked at random from a long term of years, will be of interest to Michigan growers. Results obtained in 1892.*

Plots sprayed with Bordeaux mixture gave 324 bushels per acre.

Adjoining plots unsprayed gave 100 bushels per acre.

Gain from the use of Bordeaux mixture, 224 bushels per acre.

Results of 1893, a bad blight year:

Plots sprayed with Bordeaux mixture yielded 375 bushels per acre.

Adjoining plots unsprayed yielded 121 bushels per acre.

These gains by spraying are probably a great deal larger than could be obtained in large field experiments in Michigan.

In 1900 the Maine Station† experimented in spraying for blight in a small way and the increase in yield per acre for potatoes sprayed with Bordeaux mixture was 133 bushels per acre over those not sprayed.

Perhaps, however, the most extensive and the most carefully conducted experiments in potato spraying have been carried on at the New York Experiment Station, Geneva, N. Y. The results of their first year's experiments, 1902,‡ gave a yield of 317½ bushels per acre for rows sprayed three times; 342½ bushels per acre for rows sprayed seven times, and 219 bushels per acre for those not sprayed at all. Thus the seven sprayings gave an increased yield of 123½ bushels per acre and the three sprayings 98½ bushels per acre.

The following year, 1903,¶ the Geneva Station enlarged its field of work along this line and established a number of cooperative business experiments with farmers throughout the state.

"The farmers business experiments were designed to determine the

* Vt. Bulletin No. 72, p. 15.

† Bulletin 73 Maine, p. 57.

‡ N. Y. Expt. Sta. Bulletin No. 221, pp. 235-6.

¶ For complete account see N. Y. Expt. Sta. Bull. No. 241.

actual profits in potato spraying under ordinary farm conditions." The total area thus treated in cooperation was 61½ acres sprayed in six experiments in different parts of New York. The total increase in yield due to spraying with Bordeaux Mixture was 3,746 bushels, or an average of 61.21 bushels per acre. The increase at the time of digging was worth \$1,873; the total expense of spraying was \$296.49, giving a clear profit, due to spraying, of \$1,576.51, or \$25.77 per acre.

In 1904 the work of the Geneva Station in potato spraying was continued and more cooperative business experiments were arranged;* also, a large number of volunteer experiments were reported to the Station by farmers.

"In fourteen† farmers' business experiments, including 180 acres, the average gain due to spraying, was 62¼ bushels per acre; the average cost of spraying \$4.98 per acre; and the average cost for each spraying, 93 cents per acre; and the average net profit, based on the market price of potatoes at time of digging, \$24.86 per acre."

"In forty-one farmers' volunteer experiments, including 363¾ acres, the average gain due to spraying was 58½ bushels per acre. In twenty-three of these experiments the average total cost of spraying was \$3.91 per acre; the average cost for each spraying, 90 2-3 cents; and the net profit, based on the market price of potatoes at time of digging, \$22.01 per acre."

It would seem fitting to record the results of one of these business experiments and the one chosen is known as "The West Henrietta Experiment." (For details see N. Y. Expt. Sta. Bul. No. 264, pp. 121-124.) The potato field used in this experiment was owned by Mr. Robert Dunn of West Henrietta, N. Y., and was composed of 12 acres. This field was sprayed eight times. Three rows through the middle of the field were left unsprayed. At digging time the center one of these 3 rows was dug separately, as were also the second rows of the sprayed potatoes on either side of the unsprayed ones. The yield of the unsprayed row was compared with the average yield of the two sprayed rows. The unsprayed row yielded at the rate 184 bu. 44 lbs. per acre, while the sprayed rows yielded at the rate of 314 bu. 43 lbs. per acre, making the increase due to spraying 130 bushels per acre. At time of digging the market price of potatoes was 50 cents per bushel, so the increased yield per acre was worth \$65. The cost of spraying was \$4.89 per acre, leaving a net profit of \$60.11 per acre, or \$721.32 for the 12 acres.

Mr. Dunn calculated his expense as follows:

400 lbs Copper Sulphate, at 6c	\$24 00
8 bu. Lime, at 25c.....	2 00
14 lbs. Paris Green (for bugs), at 15c.....	2 10
80 hrs. labor for man, at 15c.....	12 00
80 hrs labor for team, at 15c.....	12 00
Interest and wear on sprayer.....	6 60
Total cost of spraying 12 acres 8 times.....	\$58 70
Average cost per acre per application.....	61

* See N. Y. Expt. Sta. Bull. No. 264.

† Taken from N. Y. Expt. Sta. Bull. No. 264, p. 97.

Spraying experiments for blight have also been carried on in Rhode Island,* and in Ohio,† and in each case a marked increase in yield was noted.

These experiments from other states show that spraying for late blight pays there. Why should it not pay here in Michigan?

V. DIRECTIONS FOR SPRAYING.

Spraying for late blight should commence when the plants are about 12 inches high and should be repeated at intervals of 10 to 20 days, depending greatly upon the season. If the season should happen to be a wet one, a greater number of sprayings are necessary than if the season is an ordinary one. Advantage can be taken of the fact that the poison used in combating the potato bugs can be mixed with the Bordeaux mixture without impairing the value of either, so that when spraying with Bordeaux we can spray for bugs at the same time.

The Bordeaux mixture should contain at least 5 pounds of copper sulphate to 50 gallons of the mixture. The writer recommends the following formula for the Bordeaux mixture for use on potatoes: Five pounds Copper Sulphate, 6 pounds Stone Lime, to 50 gallons of water. These quantities are not arbitrary and doubtless many other combinations of the lime and copper sulphate can be used with success.

In order to get results, the Bordeaux mixture must be well applied and strike every part of the plant. If a crop sprayer is used, one should be selected that will throw the material up against the under side of the leaf and also give a mist-like spray.

A single spraying will be of benefit, but one must remember that in order to get control of the blight and make potato spraying pay, *the Bordeaux mixture must be on the foliage before the disease makes its appearance and that the supply must be kept up during the growing season.*

VI. WHEN SHALL WE DIG BLIGHTED POTATOES?

The rotting of the stored tubers is one of the most serious phases of the devastations wrought by the blight, and the question is often asked "Does it make any difference in the rotting if the digging is done before the tops are dead and dry, or will it pay to wait until they are?"

This subject has been investigated by Stewart and Eustace of the New York Experiment Station,‡ who say: "If the tubers are to be stored they should not be dug until the tops are dead and thoroughly dry, in order that the fungus spores may be given a chance to dry up and die. As long as the tops remain even partially green the spores of the blight fungus continue to live. In the process of digging, the tubers become covered with these live spores and if conditions are at all favorable more or less rot results. This explains why sprayed potatoes sometimes rot more in storage than unsprayed ones."

Precautions should be taken after digging not to cover the piles over

* R. I. Bull. No. 14, p. 187.

† September bulletin, Ohio Exp. Sta., 1889.

‡ Bulletin 264, pp. 202-203

night with tops that have been blighted as this would only result in additional infection with blight spores.

FURTHER EXPERIMENTATION.

It is the purpose of this Department to carry on the spraying experiments with late blight for at least five years. In order that the most reliable results may be obtained, and that the results may be spread broadcast among the potato growers of the State, it is desired that a large number of growers co-operate with the Department in this work. It is especially desired that every potato grower who sprays report his results to this Department. A certain number of experiments under the direction of the Station have been arranged for the coming season and a few more are desired. Any potato grower who wishes to enter into co-operation in this work may obtain explicit directions for carrying on an experiment by addressing the author. An endeavor will be made during the coming season to have a representative of the Station visit a number of these co-operative experiments.

Agricultural College, Mich., March 7, 1906.

BULLETIN 237.

MAY, 1906.

MICHIGAN

STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT

DIGESTER TANKAGE FOR SWINE

BY

R. S. SHAW

218

1871

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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 Chatham, Alger County, 160 acres deeded.

DIGESTER TANKAGE FOR SWINE.

The following report contains a brief statement of the results of investigations on the value of digester tankage as an adjunct to the ration in certain phases of swine feeding. The value and use of this material has been the subject of investigation elsewhere heretofore, in several ways, and has been reported on. One of the main objects in taking up this work was to secure a substitute for skim milk for young pigs from the time of weaning on to that stage of development where they are capable of using less concentrated rations containing smaller amounts of protein. An enormous quantity of milk leaves our Michigan farms annually to supply condensories, cheese factories, and city, town and village trade. Thus, many producers are left without skim milk for rearing young calves and pigs. It is generally conceded that the use of skim milk greatly simplifies the process of pig feeding from weaning time on; in fact, its use in the ration at this time is regarded by some as being indispensable. In the absence of skim milk probably the next best food factor for the young pig is middlings, but the supply and demand are frequently such that even this foodstuff is not available. These are some of the factors that led us to look for a substitute for skim milk for the young growing pig. While this work was in progress it also became possible to make some tests with tankage for the fattening hog. The tankage used had a guaranteed content of 60% protein, 10% fat and 6% phosphates. The price paid for it was \$32.50 per ton. The question is frequently asked, what is tankage? It consists of refuse materials from slaughtering, such as digestive organs and their contents, flesh scraps and some blood, and condemned carcasses which cannot be used for human food. These materials are cooked under steam pressure and then dried and ground until almost as fine as middlings.

The prices charged for the foods used in this experiment are as follows, viz.: Corn meal \$20.00 per ton, middlings \$20.00, tankage \$32.50, and skim milk 20c per hundred pounds.

The data given in this report shows that the work in each case was repeated a number of times. This duplication demonstrates marked uniformity of results in the comparative data. Our readers cannot help but note the fact that, in general, the average daily gains of the experimental pigs were not large. It is not reasonable to expect that gains from experimental animals should always reach the maximum for some rations are satisfactory and others less so. In order to test the comparative efficiency of rations, changes cannot be made in them, often for weeks at a time, whether the animals like them or not. In feeding for big gains only, the appetite of the animal can be catered to. In the case of some of these lots the pigs were on test from ten to fourteen weeks at a time. Considerable restraint is also put on experi-

mental pigs by way of confinement in pens and yards. In all the cases reported the pigs were continuously confined in pens eight or ten feet by fourteen feet, with outdoor yards of the same width as the pens, but twenty-two feet long.

PART 1.

Digester Tankage vs. Skim Milk for Growing Swine.

This experiment consisted of a series of three tests, under practically the same general plan, so that the work may be said to have been repeated three times. The six pens of pigs reported in this experiment completed the feeding periods successfully. Additional pens were started but were discarded owing to the development of undesirable factors such as unthriftiness of an individual or other causes likely to affect the accuracy of the results. The surrounding conditions were alike in every respect except that the two pens of pigs of the first series were fed during the winter season and the others during the summer.

TEST NO. 1.

Digester Tankage vs. Skim Milk for Pigs Between Four and Six Months Old.

In this test the ration for lot I consisted of cornmeal 3 parts, middlings 3 parts and tankage 1 part, mixed with water; for lot II corn meal and middlings equal parts, fed with a little more than their own weight of skim milk.

The pigs used in this case were Yorkshires and Poland Chinas; the former were farrowed September 30th, and the latter September 15th, 1904. As this feeding period began January 25th and extended to March 22, 1905, covering fifty-six days, the Yorkshires were 117 days old at the start and the Poland-Chinas 132 days. There were five pigs in each pen consisting of four Yorkshires and one Poland China. The results are summed up in the following table:

Lot No.	Weight, Jan. 25, 1905. Pounds.	Weight, March 22, 1905. Pounds.	Gains. Pounds.	Food consumed.				Total cost of food.	Cost per cwt., gain.	Food per 1 pound, gain.	
				Corn meal. Pounds.	Midd- lings. Pounds.	Tank- age. Pounds.	Skim milk. Pounds.			Meal. Pounds.	Skim milk. Pounds.
I. Five pigs.....	313.3	621	307.7	420	420	140	.....	\$10.67	\$3.46	3.18	.....
II. Five pigs.....	323.0	654	331.0	461	461	.....	980	\$11.18	\$3.37	2.78	2.96

During the 56 days of this test the five pigs of Lot I consumed an average of 3.5 pounds of meal mixture per head daily, while increasing

in live weight from 62.6 pounds to 124.2 pounds at the rate of 1.09 pounds per head daily. At the same time, the five pigs of Lot II consumed an average of 3.29 pounds meal mixture and 3.5 pounds skim milk, while increasing in live weight from 64.6 pounds to 130.8 pounds at the rate of 1.18 pounds per head daily. Though the rate of gain and cost of production in this test are slightly in favor of the skim milk fed pigs, still, the margin of difference in both instances is extremely small. Throughout this test absolutely no difference could be detected between the two pens as to thriftiness and feeding quality.

TEST NO. 2.

Digester Tankage vs Skim Milk for Growing Swine Between 58 and 128 Days of Age.

In this test the ration for Lot III was made up in the following proportions by weight, viz.: Middlings 20 pounds, corn meal 10 pounds and digester tankage 3 pounds; the tankage formed one-eleventh of the mixture. To this food sufficient water was added to form a slop. Lot IV was fed a ration of the following proportions, viz.: Middlings 20 pounds, corn meal 10 pounds and skim milk 90 pounds, three pounds of skim milk being used to every pound of meal mixture.

The animals used in this test were the offspring of a Duroc-Jersey boar and Tamworth sow. Twelve pigs were farrowed March 12, 1905, but only eight were raised. On May 9th, when these pigs were 58 days old, they were weaned and divided into two lots of four each, according to weight and quality. There was one barrow and three sows in each pen.

The results of this test are summed up in the following table:

Lot No.	Weight, May 9, 1905. Pounds.	Weight, July 18, 1905. Pounds.	Gains. Pounds.	Food consumed.				Total cost of food.	Cost per cwt., gain.	Food per pound, gain	
				Corn meal. Pounds.	Midd- lings. Pounds.	Tank- age. Pounds.	Skim milk. Pounds.			Meal. Pounds.	Skim milk. Pounds.
III. Four pigs....	159	443	284	266.7	533.3	80	.....	\$9.30	\$3.27	3.09	.....
IV. Four pigs....	152	463	311	245.5	491.0	.....	2209.5	\$11.78	\$3.78	2.36	7.1

During the 70 days of this test the four pigs of Lot III consumed an average of 3.14 pounds of their meal mixture per head daily, while increasing in live weight from 39.7 pounds to 110.7 pounds at the rate of 1.01 pounds per head daily. At the same time the four pigs of Lot IV consumed on an average 2.63 pounds of their meal mixture and 7.89 pounds skim milk per head daily, while increasing in live weight from 38 pounds to 115.7 pounds at the rate of 1.11 pounds per head daily.

In this test the actual increase in live weight was a trifle greater for Lot IV receiving skim milk, but the cost of production per cwt. was 51c less for Lot III receiving tankage in the place of skim milk. No

difference was apparent in the relative condition of the pigs in the two lots.

TEST NO. 3.

Digester Tankage vs. Skim Milk for Growing Swine Between 50 and 120 Days of Age.

In this test the ration for Lot V was made up in the following proportions by weight, viz.: Middlings 20 pounds, corn meal 10 pounds and digester tankage 3 pounds; the tankage formed one-eleventh of the mixture. This ration was made into a slop by adding water. Lot VI was fed a ration of the following proportions, viz.: Middlings 20 pounds, corn meal 10 pounds and skim milk 90 pounds, three pounds of skim milk being used to every pound of meal mixture. These rations duplicate those of Test No. 2.

The pigs used in this test were the offspring of a Berkshire boar and Tamworth sow and were farrowed March 27, 1905. There were twelve pigs in the litter and ten were raised. On May 16th, when these pigs were 50 days old, about weaning time, they were divided into two lots of five each, there being two barrows and three sows in each pen.

The results of this test are summed up in the following table.

Lot No.	Weight May 16, 1905. Pounds.	Weight July 25, 1905. Pounds.	Gains. Pounds.	Food consumed.				Total cost of food.	Cost per cwt., gain.	Food per pound, gain.	
				Corn meal Pounds.	Midd- lings. Pounds.	Tank- age. Pounds.	Skim milk. Pounds.			Meal Pounds.	Skim milk. Pounds.
V. Five pigs.....	183	478	295	282.4	564.8	84.8	.....	\$9.85	\$3.33	3.15	.....
VI. Five pigs.....	184	523	339	262.7	525.3	.....	2,364	\$12.60	\$3.71	2.32	6.97

During the 70 days of this test the five pigs of Lot V consumed on an average 2.66 pounds meal mixture per head daily, while increasing in live weight from 36.6 pounds to 95.6 pounds at the rate of .84 pounds per head daily. At the same time the five pigs of Lot VI consumed on an average 2.25 pounds meal mixture and 6.75 pounds skim milk per head daily, while increasing in live weight from 36.8 pounds to 104.6 pounds at the rate of .96 pounds per head daily. The results of this test agree exactly with those of test 2. Where skim milk was fed in this case the gains were slightly larger, but the cost of production where tankage was used was 38 cents less per cwt. gain.

CHECK TEST.

A check test was conducted for ten weeks, in which two lots of pigs of five each were fed on a ration consisting of middlings 2 parts and corn meal one part, made into a thick slop by adding water. Attention is called to the fact that this ration duplicates those of the previous tests, in-so-far as it contains middlings and corn meal in the same propor-

tions as in tests 2 and 3, but does not contain either tankage or skim milk. The ration used in this case therefore serves as an indicator to the value of both skim milk and tankage.

The pigs used in this case were Yorkshire-Chester and Yorkshire-Berkshire crosses divided as evenly as possible as regards breeding, size and quality. These pigs went on feed at about the same average weights as those of the previous tests, but were some older and were fed seventy days.

The following are the results of this check test:

Lot No.	Weight July 18, 1905. Pounds.	Weight Sept. 26, 1905. Pounds.	Gains. Pounds.	Food consumed.				Total cost of food.	Cost per cwt., gain.	Food per pound, gain.	
				Corn meal. Pounds.	Midd- lings. Pounds.	Tank- age. Pounds.	Skim milk. Pounds.			Meal. Pounds.	Skim milk. Pounds.
VII. Five pigs...	265	554	289	386.8	773.7	.....	.....	\$11.60	\$4.01	4.01	.....
VIII. Five pigs...	258	535	277	386.8	773.7	.....	.....	\$11.60	\$4.18	4.18	.....

In the three tests including tankage and skim milk, the average cost of production per cwt. with the tankage rations was \$3.35, with the skim milk rations \$3.62, and with the check ration of middlings, corn meal and water \$4.09. In the three original tests the tankage ration pigs consumed an average 3.14 pounds meal mixture per pound gain, those receiving skim milk in the ration required 2.48 pounds meal mixture and 5.67 pounds skim milk per pound gain. In the check ration consisting of corn meal and middlings the average amount of meal mixture required per pound gain was 4.09 pounds. The average daily gains from the three tankage rations was .98 pounds, from the three skim milk rations 1.08 pounds, and from the check ration .8 pounds. Judging from these figures we are therefore quite safe in concluding that though the ration containing skim milk made a slightly greater gain than where tankage was used, the cost of producing this increased gain was somewhat greater. Also that the check ration of middlings and corn meal only, produced smaller gains at a greater cost than either of the others. The amount of dry matter required per pound gain with both tankage and skim milk rations was about the same; in the check ration it was somewhat greater.

PART 2.

DIGESTER TANKAGE FOR FATTENING SWINE.

This part of the report deals with the use of digester tankage in the ration for swine being fitted or finished for market; or, in other words, the development of the hog from say one hundred and twenty pounds

weight to the weight and finish demanded by the market, between two hundred and two hundred and fifty pounds.

This experiment consisted of a series of four tests, with two pens of pigs in each case. The rations were not all alike. In the first two tests the rations were, on the one hand, corn meal and tankage, and on the other, corn meal only. In the other two tests of this series one ration was made up of corn meal, middlings and tankage, and the other of corn meal and middlings. Middlings were used more freely in the latter tests because they were considerably cheaper than corn at the time of purchase.

TEST NO. 1.

Digester Tankage and Corn Meal vs. Corn Meal Alone for Fattening Pigs.

The ration for lot IX consisting of tankage and corn meal was made up of 5 parts corn meal and 1 part tankage by weight; both this ration and the one consisting of corn meal only, for Lot X, were made into a thick slop for feeding, by adding water.

The animals used were purchased for the experiment and consisted of eight Duroc Jerseys farrowed in July, 1904; these pigs had been run on pasture during the open season with little grain feed and as a result only averaged 120.5 pounds per head when put on feed January 25, 1905, for the 70-day test.

The following table gives the results of this test:

Lot No.	Weight, Jan. 25, 1905. Pounds.	Weight, April 5, 1905. Pounds.	Gains. Pounds.	Food consumed				Total cost of food.	Cost per cwt., gain.	Food per pound, gain.	
				Corn meal. Pounds.	Midd- lings. Pounds.	Tank- age Pounds.	Skim milk. Pounds.			Meal. Pounds.	Skim milk. Pounds.
IX. Four pigs....	480.6	927	446.4	1,335	.....	267	.....	\$17.69	\$3.96	3.58	.....
X. Four pigs....	484	865.6	381.6	1,426	.....	.....	.....	\$14.26	\$3.73	3.73	.....

Attention is directed to the fact that the tankage formed one-sixth of the meal ration for Lot IX, and because of its large proportion and greater cost, the cost of production was rendered greater despite the fact that the gains were larger. During the seventy days of this test the four pigs of Lot IX consumed on an average 4.76 pounds of corn meal and .95 pound tankage per head daily, while increasing in live weight from 120.15 to 231.75 pounds at the rate of 1.59 pounds per head daily. During this same time the four pigs of Lot X consumed an average of 5.09 pounds corn meal per head daily, while increasing in live weight from 121 pounds to 216.4 pounds at the rate of 1.36 pounds per head daily.

TEST NO. 2.

Digester Tankage and Corn Meal vs. Corn Meal Alone for Fattening Pigs.

In this case the ration for Lot XI consisted of corn meal 9 pounds and tankage 1 pound, the tankage forming but one-tenth of the entire ration. The ration for Lot XII consisted of corn meal only and both rations were fed as a thick slop by adding water.

The pigs used in this case were somewhat heavier than those of test one at the beginning of the experiment, averaging 155.25 pounds, but were fed to greater weights covering a period of eighty-four days.

The following table gives the results of this test:

Lot No.	Weight Nov. 7, 1905. Pounds.	Weight Jan. 30, 1906. Pounds.	Gains. Pounds.	Food consumed:				Total cost of food.	Cost per cwt., gain.	Food per pound, gain.	
				Corn meal Pounds.	Mid- lings. Pounds.	Tank- age. Pounds.	Skim milk. Pounds.			Meal. Pounds.	Skim milk. Pounds.
XI. Four pigs...	624	1,016	392	1525.5	.....	169.5	.....	\$18.00	\$4.59	4.32	.....
XII. Four pigs...	618	915.3	297.3	1,624	.....	.....	.....	\$16.24	\$5.46	5.46	.....

During the eighty-four days of this test the four pigs of Lot XI consumed an average of 4.54 pounds corn meal and .5 pounds tankage per head daily, while increasing in live weight from 156 to 254 pounds at the rate of 1.16 pounds per head daily. At the same time the four pigs of Lot XII consumed on an average 4.83 pounds corn meal per head daily, while increasing in live weight from 154.5 pounds to 228.8 pounds at the rate of .88 pounds per head daily. In this test and also in No. 1, it was a noticeable fact that the corn meal fed pigs kept pace with the corn meal and tankage fed pigs for a time, but the gains of the latter became increasingly greater as the feeding period advanced. We should not expect the advantages of the balanced ration to show markedly on a short feed.

Though absolutely greater, the comparative cost of production is less in test 2 where tankage formed but one-tenth of the ration than where it formed one-sixth in test-1.

TEST NO. 3.

Digester Tankage for Fattening Swine.

Tests Nos. 3 and 4, of part 2, differ only from Tests 1 and 2 in that middlings was introduced into both rations.

In this test the ration for Lot XIII was made up as follows: Middlings 20 pounds, corn meal 10 pounds and tankage 3 pounds, the latter forming one-eleventh of the ration; the ration of lot XIV consisted of middlings 20 pounds and corn meal 10 pounds.

The pigs of these two lots, a Duroc Tamworth cross, were put on feed

at an average of 113.25 pounds, and weighed 215.5 pounds each at the end of fourteen weeks.

The following is a summary of the test:

Lot No.	Weight, July 18, 1905, Pounds.	Weight, Oct. 24, 1905, Pounds.	Gains, Pounds.	Food consumed.				Total cost of food.	Cost per cwt., gain.	Food per pound, gain.	
				Corn meal, Pounds.	Mid- dlings, Pounds.	Tank- age, Pounds.	Skim milk, Pounds.			Meal, Pounds.	Skim milk, Pounds.
XIII. Four pigs..	443	876	433	577.5	1155.25	173.25	.....	\$20.14	\$4.65	4.4	.....
XIV. Four pigs..	463	848	385	613.7	1227.3	.....	.....	\$18.41	\$4.78	4.78	.....

During the 98 days of this test the four pigs of Lot XIII consumed on an average 4.86 pounds of their meal mixture per head daily, while increasing in live weight from 110.7 pounds to 219 pounds at the rate of 1.1 pounds per head daily. At the same time the four pigs of Lot XIV consumed on an average 4.69 pounds of their meal mixture per head daily, while increasing in live weight from 115.7 pounds to 212 pounds at the rate of .98 pounds per head daily.

TEST NO. 4.

Digester Tankage for Fattening Swine.

This is a duplication of Test No. 3, Part 2, except that five pigs were used in each lot instead of four, and the experiment was one week later starting. The pigs in test 3 were Duroc Tamworth cross, those in 4 a Berk-Tamworth cross. The pigs of these two lots were put on feed at an average weight of 100.1 pounds and finished fourteen weeks later at an average weight of 179.5 pounds.

The following is a summary of the test.

Lot No.	Weight, July 25, 1905, Pounds.	Weight, Oct. 31, 1905, Pounds.	Gains, Pounds.	Food consumed.				Total cost of food.	Cost per cwt., gain.	Food per pound, gain.	
				Corn meal, Pounds.	Mid- dlings, Pounds.	Tank- age, Pounds.	Skim milk, Pounds.			Meal, Pounds.	Skim milk, Pounds.
XV. Five pigs..	478	927	449	586.7	1173.3	176	.....	\$20.46	\$4.55	4.31	.....
XVI. Five pigs...	523	868	345	630.3	1260.7	.....	.....	\$18.91	\$5.48	5.48	.....

During the 98 days of this test the five pigs of Lot XV consumed on an average 3.95 pounds meal mixture per head daily, while increasing in live weight from 95.6 pounds to 185.4 pounds at the rate of .91 pounds per head daily. At the same time the five pigs of Lot XVI consumed on an average 3.85 pounds meal mixture per head daily, while increasing

in live weight from 104.6 pounds to 173.6 pounds at the rate of .7 pounds per head daily. The appetites of the pigs receiving tankage in their ration was better than where corn only was used and their coats were smoother and more oily looking.

SUMMARY.

1. The indications from the results given in Part 1 are that digester tankage can be used successfully as a substitute for skim milk in the ration for the growing pig, from weaning time on.

2. In Tests 2 and 3, Part 1, the following rations were used, viz.: First, middling 20 pounds, corn meal 10 pounds, tankage 3 pounds, the last forming 1-11 of the ration; second, middling, 20 pounds, corn meal 10 pounds, and skim milk 90 pounds. In both cases the gains from the skim milk ration were a little greater, but the cost of production from the tankage ration was much less. This would seem to suggest that a slightly greater proportion of tankage than 1-11 of the ration could be fed, increasing the gains somewhat, and still keeping within the cost of production of the skim milk ration.

3. The check ration of middlings 20 pounds and corn meal 10 pounds mixed with water, produced smaller gains at a greater cost than either of the rations containing tankage or skim milk.

4. In Tests 1 and 2, Part 2, corn meal and tankage in the proportions of 5 and 1, and 9 and 1, were compared with rations of pure corn meal; in tests 3 and 4, the two rations were made up as follows, viz.: First, middlings 20 pounds, corn meal 10 pounds, and tankage 3 pounds, the last forming 1-11 of the ration, and second, middlings 20 pounds and corn meal 10 pounds. The following conclusions may be withdrawn:

(1.) The gains were greatest in every case where tankage was used in the ration, and

(2.) This was more and more noticeable as the feeding period was prolonged.

(3.) Test 2 was conducted 84 days, and in it tankage formed 1-10 of the ration; tests 3 and 4 were conducted 98 days and in them tankage formed 1-11 of the ration: in all three the cost of production was less where the tankage ration was used. In Test 1, conducted 70 days, with tankage forming 1-6 of the ration, the gains, though greater, were a few cents per cwt. more expensive in the tankage ration.

5. In general the figures given indicate that tankage can be used to good advantage in the ration for the fattening hog, as well as for the growing pig.

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BULLETIN 238.



MAY, 1906.

MICHIGAN



STATE AGRICULTURAL COLLEGE

EXPERIMENT STATION

FARM DEPARTMENT

FIRST ANNUAL REPORT OF GRADE DAIRY HERD

BY

R. S. SHAW AND A. C. ANDERSON

AGRICULTURAL COLLEGE, MICHIGAN

1906.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Secretary, Agricultural College, Michigan.

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 South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
 Chatham, Alger County, 160 acres deeded.

ROOTS SUPPLEMENTARY TO SILAGE FOR DAIRY COWS.

BY R. S. SHAW AND H. W. NORTON, JR.

[The plans of this experiment were executed and the data prepared for publication by Mr. Norton.]

The object of this series of experiments was to determine whether the addition of roots to a complete ration containing silage would increase the milk flow profitably, or not. It was in no sense a comparison of the values of silage and roots, as that question has been investigated heretofore and reported upon by the Pennsylvania Station, in bulletin 26, and by Ohio, in bulletin 50.

By the use of the term complete, as applied to the ration of the dairy cow in this case, we imply a proper balance with reference to the relative amounts of hay, silage, and concentrates when the cow is consuming all she cares for of each. An animal may be said to be on full feed as regards a certain ration and still may be induced to consume more if an additional factor, especially palatable, is added. Scientific and practical men agree that succulence is essential in the ration of the dairy cow, and some have claimed that silage furnishes this quality perfectly, hence the suggestion of this line of work. We should expect entirely different results where less than a full feed of silage was given and a marked advantage in favor of root feeding in a case where silage was not available.

GENERAL PLAN.

Three separate feeding trials were made and a total number of 40 cows used. In each case they were divided into two lots equal in number, and as nearly alike as possible from the standpoint of condition of flesh, time from calving, and previous production when on the same feed. The feeding trials covered eight weeks, and were divided into two four-weeks periods. During the first period Lot 1 received roots in addition to the regular ration; during the second period Lot 2 received roots in addition, while Lot 1 received only the regular feed. Every cow was weighed three successive days at the beginning of the first period, at the beginning of the second and at the close of the second period, the averages being taken as the correct weights for each time.

Daily records were kept of all feed consumed and all milk produced, each milking being weighed and sampled, the samples preserved and tested weekly for butter fat.

All the cows under experiment were fed regularly, stabled alike, turned out to water once a day during the early spring, twice a day later, and given the same general care and treatment. Reversing the root feeding in the two periods, so that Lot 2 consumed the same amount of roots as Lot 1, tended to equalize any differences due to the individuality which would otherwise have rendered the results inaccurate. In order that the trials should be fairly comparable the same scale of prices was used in figuring the results, in both years, 1905 and 1906.

PRICES OF FEEDS.

Silage	\$2.50 per ton.
Clover hay	5.00 per ton.
Roots	2.00 per ton.
Dried beet pulp	15.00 per ton.
Corn meal	20.00 per ton.
Oats	20.00 per ton.
Bran	18.00 per ton.
Gluten feed	20.00 per ton.
Oil cake	28.00 per ton.

Three grain mixtures were used, as follows:

Grain mixture No. 1 cost \$17.60 per ton.

Dried beet pulp	4 parts.
Oats	3 parts.
Bran	2 parts.
Gluten feed	1 part.

Grain mixture No. 4 cost \$20.28 per ton.

Bran	3 parts.
Corn meal	3 parts.
Oil cake	1 part.

Grain mixture No. 5 cost \$19.21 per ton.

Bran	6 parts.
Corn meal	3 parts.
Dried beet pulp	3 parts.
Oil cake	2 parts.

FEEDING TRIAL—NUMBER ONE.

In the spring of 1905, sixteen cows of Grade Herd No. 1 were selected as described above and divided into two lots of eight cows each. During the first period of four weeks, Lot 1 received, in addition to the regular herd ration of silage, hay and grain, 15 pounds of roots per head daily. During the second period, Lot 2 received the same amount of roots instead of Lot 1. The last period, however, covered only two weeks, as the supply of roots at that time was exhausted and the results given herein are reported in weekly averages in order to furnish a fair basis for comparison. Lot 1 consisted of Nos. 11, 12, 14, 19, 21, 23, 24, 31. Lot 2, of Nos. 13, 17, 20, 22, 25, 27, 28, 32.

AVERAGE RATIONS CONSUMED.

Lot 1.

	First Period.	Second Period.
Silage	42.4 lbs. per day	42.9 lbs. per day
Hay	4.0 lbs. per day	3.8 lbs. per day
Grain (No. 1)	8.0 lbs. per day	8.1 lbs. per day
Roots	15.0 lbs. per day	

Lot 2.

	First Period.	Second Period.
Silage	46.1 lbs. per day	47.0 lbs. per day
Hay	4.0 lbs. per day	3.75 lbs. per day
Grain (No. 1)	8.0 lbs. per day	8.2 lbs. per day
Roots		15.0 lbs. per day

The average ration taken from both lots when fed roots as against both lots when off roots, is as follows

AVERAGE RATION FOR BOTH LOTS.

Lots 1 and 2 With Roots.		Lots 1 and 2 Without Roots.	
Silage	44.7 lbs.	Silage	44.5 lbs.
Hay	3.87 lbs.	Hay	3.90 lbs.
Grain	8.10 lbs.	Grain	8.05 lbs.
Roots	15.0 lbs.	Roots	00 lbs.

A comparison of the above table of rations shows a very slight difference in the rations as consumed during the two periods aside from the root factor.

The tables following show the production in milk and butter fat, cost of same, and cost of ration on the weekly average.

TABLE 1.—LOT 1.

ROOTS.

Averages for four weeks.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
11.....	167.5 lbs.	\$1.108	\$0.661	6.448 lbs.	\$0.171
12.....	166.4 lbs.	.966	.598	6.903 lbs.	.144
14.....	188.3 lbs.	1.109	.588	7.202 lbs.	.153
19.....	136.6 lbs.	1.063	.778	6.441 lbs.	.165
21.....	126.5 lbs.	.968	.765	5.471 lbs.	.176
23.....	216.3 lbs.	1.008	.466	7.299 lbs.	.138
24.....	186.3 lbs.	1.052	.564	8.007 lbs.	.131
31.....	174.7 lbs.	1.011	.578	6.633 lbs.	.152
Average.....	170.32 lbs.	1.039	\$0.6247	6.800 lbs.	\$0.1537

NO ROOTS.

Averages for two weeks.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
11.....	162.9 lbs.	\$1.023	\$0.627	6.596 lbs.	\$0.155
12.....	155.7 lbs.	.927	.595	6.385 lbs.	.145
14.....	177.3 lbs.	1.023	.576	7.181 lbs.	.142
19.....	135.6 lbs.	.943	.695	6.104 lbs.	.154
21.....	126.7 lbs.	.905	.714	5.323 lbs.	.170
23.....	187.1 lbs.	.830	.443	6.454 lbs.	.128
24.....	166.9 lbs.	.951	.569	6.844 lbs.	.138
31.....	162.9 lbs.	.927	.569	5.863 lbs.	.168
Average.....	159.38 lbs.	.9411	.5985	6.343 lbs.	.1487

TABLE 2.—LOT 2.

NO ROOTS.

Averages for four weeks.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
13.....	200.2 lbs.	\$1.036	\$0.517	8.611 lbs.	\$0.120
17.....	156.4 lbs.	.894	.571	7.812 lbs.	.114
20.....	134.1 lbs.	.972	.724	5.363 lbs.	.181
22.....	181.2 lbs.	.951	.524	6.659 lbs.	.142
25.....	185.8 lbs.	1.015	.546	6.741 lbs.	.150
27.....	166.4 lbs.	.957	.575	5.955 lbs.	.160
28.....	186.5 lbs.	1.019	.546	6.855 lbs.	.148
32.....	120.9 lbs.	.868	.717	5.240 lbs.	.165
Average.....	166.43 lbs.	\$0.964	\$0.590	6.654 lbs.	\$0.1475

ROOTS.

Averages for two weeks.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
13.....	199.9 lbs.	\$1.203	\$0.601	8.997 lbs.	\$0.133
17.....	152.6 lbs.	1.031	.675	7.630 lbs.	.135
20.....	133.2 lbs.	1.111	.834	5.593 lbs.	.198
22.....	170.7 lbs.	1.067	.625	6.488 lbs.	.164
25.....	192.1 lbs.	1.146	.596	7.204 lbs.	.159
27.....	172.2 lbs.	1.071	.621	6.120 lbs.	.175
28.....	191.6 lbs.	1.137	.593	6.994 lbs.	.162
32.....	125.2 lbs.	.961	.767	5.136 lbs.	.187
Average.....	167.13 lbs.	\$1.090	\$0.664	6.770 lbs.	\$0.1641

A study of Table 1 shows a considerable decrease in production, when the roots were dropped out of the rations, which could hardly be entirely due to the advance in the period of lactation. The average weekly production of milk was 10.94 lbs. greater, and of butter fat .457 lb. greater on the root ration. The average weekly cost of the ration, however, was increased by 9.8 cents. The cost of production per cwt. of milk was 2.6 cents greater, and per pound of butter fat .5 cent greater on the root ration.

Table 2 shows a slight increase both in milk and butter fat production, amounting to .75 lb. milk and .116 lb. butter fat, while without the addition of the roots we would expect a decrease because of the advance in the lactation period. The cost of the ration increased with roots 12.6 cents per week, milk cost 7.4 cents more per cwt. and butter fat 1.66 cents more per lb.

TABLE 3.

Average for both lots with and without roots.

Lots 1 and 2.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
With roots.....	168.75 lbs.	\$1.064	\$0.6443	6.785 lbs.	\$0.1589
Without roots.....	162.90 lbs.	.952	.5942	6.498 lbs.	.1481
Difference.....	5.85 lbs.	\$0.112	\$0.0501	.287 lbs.	\$0.0108

In Table 3 the results were averaged from the sixteen cows, while on the "root ration," against the same sixteen when fed without roots. Here it may be seen that both the milk and butter fat were increased by the addition of roots, but the added cost was great enough to render it unprofitable feeding, the average cost of production being 5 cents greater per 100 lbs. of milk and 1.12 cents greater per pound of butter fat.

FEEDING TRIAL—NUMBER TWO.

In the spring of 1906 fourteen cows from the Grade Herd No. 1 were selected in the same manner as in the previous trial and divided into two lots of seven each. The feeding, care and treatment previous to this experiment had been the same. The experiment covered two periods of four weeks each. Four days were taken at the start to get Lot 1 on the root ration, and four days to get Lot 2 on the root ration at the beginning of the second period. During the first period Lot 1 received in addition to the regular herd ration of silage, clover hay, and grain, 20 lbs. per head daily of sliced roots. During the second period the roots were placed in the ration of Lot 2, and Lot 1 received none. The roots were fed twice daily, 10 lbs. at the morning and 10 lbs. at the evening feed. Grain Mixture No. 5 was replaced by Grain Mixture No. 4 during the latter part of the test. About the middle of the last period the silage supply became exhausted, and beet pulp, thoroughly moistened, was substituted in its place. The dried beet pulp used for this purpose was soaked several hours. Feeding the moistened pulp increased the milk flow very markedly, but as it was fed in equal amounts to both lots the accuracy of the results need not be affected.

Lot 1 consisted of cows Nos. 12, 18, 23, 24, 25, 28, 32. Lot 2, cows Nos. 11, 13, 19, 20, 26, 27 and 31.

AVERAGE DAILY RATIONS CONSUMED.

Lot No. 1.

	First Period.	Second Period.
Silage	31.8 lbs.	13.4 lbs.
Pulp .....	....	5.8 lbs.
Hay	4.2 lbs.	5.35 lbs.
Grain	8.1 lbs.	8.0 lbs.
Roots	20.0 lbs.	....

Lot 2.

	First Period.	Second Period.
Silage	31.5 lbs.	12.8 lbs.
Pulp .....	....	5.8 lbs.
Hay	4.2 lbs.	5.35 lbs.
Grain	8.5 lbs.	7.9 lbs.
Roots .....	....	20.0 lbs.

Taking an average of the rations consumed by Lots 1 and 2 while on roots as against Lots 1 and 2 while receiving no roots, we find the rations were almost exactly the same, aside from the roots.

AVERAGE RATION FOR BOTH LOTS.

	Lots 1 and 2 With Roots.	Lots 1 and 2 Without Roots.
Silage	22.3 lbs.	22.4 lbs.
Pulp	2.9 lbs.	2.9 lbs.
Hay	4.8 lbs.	4.8 lbs.
Grain	8.0 lbs.	8.2 lbs.
Roots	20.0 lbs.	....

Tables 4 and 5 give the average weekly milk production, cost of ration, cost of milk per 100 lbs., average weekly butter fat production and cost per pound for all cows in both lots during the entire test.

TABLE 4.—LOT 1.

ROOTS.					
Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
12.....	156.8 lbs.	\$0.961	\$0.612	6.463 lbs.	\$0.148
18.....	194.1 lbs.	1.171	.603	6.701 lbs.	.174
23.....	177.8 lbs.	1.118	.628	7.142 lbs.	.156
24.....	162.6 lbs.	1.118	.687	7.356 lbs.	.151
25.....	151.7 lbs.	.925	.609	5.424 lbs.	.170
28.....	131.4 lbs.	.925	.703	5.028 lbs.	.183
32.....	156.1 lbs.	1.052	.673	5.702 lbs.	.184
Average.....	161.5 lbs.	\$1.038	\$0.645	6.259 lbs.	\$0.1665
NO ROOTS.					
Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
12.....	160.1 lbs.	\$1.061	\$0.662	6.054 lbs.	\$0.175
18.....	204.4 lbs.	1.143	.559	6.897 lbs.	.165
23.....	174.2 lbs.	1.133	.650	6.867 lbs.	.164
24.....	170.3 lbs.	1.109	.651	6.465 lbs.	.171
25.....	150.0 lbs.	.960	.640	5.104 lbs.	.188
28.....	128.6 lbs.	.960	.746	4.667 lbs.	.210
32.....	150.5 lbs.	1.090	.724	5.428 lbs.	.200
Average.....	162.5 lbs.	\$1.065	\$0.661	5.911 lbs.	\$0.1818

TABLE 5.—LOT 2.

NO ROOTS.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
11	161.2 lbs.	\$0.978	\$0.606	5.682 lbs.	\$0.172
13	149.6 lbs.	.972	.649	6.814 lbs.	.142
19	107.4 lbs.	.785	.731	4.898 lbs.	.160
20	134.8 lbs.	.930	.689	5.323 lbs.	.174
26	137.4 lbs.	.930	.676	5.192 lbs.	.179
27	147.8 lbs.	.918	.621	5.272 lbs.	.174
31	159.1 lbs.	.930	.584	5.966 lbs.	.155
Average.....	142.4 lbs.	\$0.920	\$0.6508	5.592 lbs.	\$0.1651

ROOTS.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
11	180.7 lbs.	\$1.279	\$0.708	6.583 lbs.	\$0.194
13	184.4 lbs.	1.226	.664	7.494 lbs.	.163
19	132.0 lbs.	1.009	.832	5.394 lbs.	.203
20	157.9 lbs.	1.230	.778	5.677 lbs.	.216
26	159.4 lbs.	1.230	.771	5.343 lbs.	.232
27	165.1 lbs.	1.053	.637	5.946 lbs.	.177
31	174.9 lbs.	1.247	.712	6.067 lbs.	.205
Average.....	164.9 lbs.	\$1.194	\$0.7288	6.070 lbs.	\$0.1985

The addition of the moistened beet pulp to the ration during the latter period with Lot 1, when no roots were fed, seems to have kept the production, both in milk and butter fat, on a level with the first period, when roots were fed, but raised the cost of ration and the cost of production. With Lot 2 the beet pulp was fed in the same period with the roots, so that while the two stimulated both milk and butter fat production to a considerable degree beyond that of the first period, still the cost of the ration and of milk and butter fat was increased very materially. A fair way of comparison here would be to average together the periods when each lot was fed roots against the periods when they received no roots in the ration. This would eliminate the beet pulp factor, both sides having received equal amounts.

TABLE 6.

Table showing average production of Lots 1 and 2 on Root Ration vs. Ration Without Roots.

Lots 1 and 2.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
Roots.....	163.20 lbs.	\$1.116	\$0.6869	6.164 lbs.	\$0.1825
No roots.....	152.45 lbs.	.992	.6559	5.751 lbs.	.1734
Difference.....	10.75 lbs.	\$0.124	\$0.0310	.413 lbs.	\$0.0091

This table shows, on an average taken from fourteen cows in two four-weeks feeding periods, that the addition of twenty pounds of roots to the daily ration increased the milk production 10.75 lbs. per week, and the butter fat production .413 lb. per week, but the cost of the ration was increased 12.4 cents per week; the cost of 100 lbs. milk increased 3.1 cents, and butter fat cost 0.91 cent more per pound than on the ration containing no roots.

WEIGHTS.

Average weight 14 cows at start of root ration.....	985.5 lbs.
Average weight 14 cows at close of root ration.....	993.2 lbs.

Average gain per cow in four weeks on roots..... 7.7 lbs.

Average weight 14 cows at start of ration without roots....	1006.0 lbs.
Average weight 14 cows at close of ration without roots....	975.3 lbs.

Avg. loss per cow in four weeks on ration without roots 30.7 lbs.

The root ration, therefore, seemed to keep the cows in somewhat better condition of flesh, as a considerable loss in weight followed the removal of roots from the ration.

FEEDING TRIAL—NUMBER THREE.

This was carried out in the spring of 1906 with two lots of five cows each, selected from Grade Herd No. 2. As in the two experiments reported above, precautions were taken to divide the lots as evenly as possible from previous production and period of lactation. All ten cows had been on the same feed up to the beginning of the test, namely, silage, clover hay, and grain, and were continued on the same ration throughout the experiment, except for the addition of 20 lbs. of roots per head daily to Lot 1 during the first four weeks, and the same to Lot 2 during the second period of four weeks.

The roots were fed twice daily, 10 lbs. at a feed.

Lot 1 consisted of Nos. 11, 12, 13, 14, 16, and Lot 2 of Nos. 15, 17, 18, 19 and 20.

The average rations consumed per head daily for the two lots follow:

Lot 1.

	First Period.	Second Period.
Silage	24. lbs.	25.2 lbs.
Hay	6.8 lbs.	6.0 lbs.
Grain	8.5 lbs.	8.5 lbs.
Roots	20.0 lbs.	....

Lot. 2.

	First Period.	Second Period.
Silage	25.5 lbs.	25.3 lbs.
Hay	6.8 lbs.	6.0 lbs.
Grain	8.8 lbs.	8.8 lbs.
Roots .....	....	20.0 lbs.

Taking an average of the rations consumed by both lots on roots, as against both lots without roots, and the difference aside from the presence or absence of roots is so small that it would have practically no bearing upon the results.

AVERAGE RATION FOR BOTH LOTS.

	Lots 1 and 2. Ration with roots.	Lots 1 and 2. Ration without roots.
Silage	24.65 lbs.	25.35 lbs.
Hay	6.4 lbs.	6.4 lbs.
Grain	8.65 lbs.	8.65 lbs.
Roots	20.00 lbs.	....

Tables 7 and 8 show the average weekly milk and butter fat production, average weekly cost of ration, and cost of milk and butter fat.

TABLE 7.—LOT 1.
ROOTS.

First period, four weeks.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
11.....	141.9 lbs.	\$1.093	\$0.7702	5.605 lbs.	\$0.1950
12.....	178.8 lbs.	1.093	.6113	6.879 lbs.	.1589
13.....	159.2 lbs.	1.093	.6867	5.489 lbs.	.1991
14.....	213.3 lbs.	1.187	.5611	8.586 lbs.	.1394
16.....	149.3 lbs.	.989	.6629	6.045 lbs.	.1637
Average.....	168.5 lbs.	\$1.093	\$0.6584	6.520 lbs.	\$0.1712

NO ROOTS.

Second period, four weeks.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
11.....	131.5 lbs.	\$0.950	\$0.722	5.261 lbs.	\$0.180
12.....	168.6 lbs.	.950	.563	6.496 lbs.	.146
13.....	148.9 lbs.	.950	.638	5.657 lbs.	.167
14.....	173.9 lbs.	1.020	.586	7.430 lbs.	.137
16.....	133.7 lbs.	.845	.632	5.582 lbs.	.151
Average.....	151.3 lbs.	\$0.943	\$0.628	6.085 lbs.	\$0.156

Table 7 shows a weekly increase of 17.2 lbs. in milk and .435 lb. in butter fat production when on root ration, but at an increased cost of 3.0 cents per 100 lbs. of milk, and 1.5 cents per pound of butter fat, because of the extra cost of the ration amounting to 15.0 cents per week.

TABLE 8.—LOT 2.

NO ROOTS.

First period, four weeks.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
15.....	143.7 lbs.	\$0.965	\$0.671	5.895 lbs.	\$0.163
17.....	188.0 lbs.	1.071	.569	7.003 lbs.	.151
18.....	173.2 lbs.	.967	.558	6.409 lbs.	.150
19.....	149.2 lbs.	.967	.648	5.520 lbs.	.175
20.....	153.6 lbs.	.967	.621	6.610 lbs.	.146
Average.....	161.9 lbs.	\$0.987	\$0.613	6.287 lbs.	\$0.157

ROOTS.

Second period, four weeks.

Number of cow.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
15.....	153.0 lbs.	\$1.090	\$0.712	5.967 lbs.	\$0.182
17.....	197.9 lbs.	1.194	.603	7.568 lbs.	.157
18.....	175.0 lbs.	1.090	.622	6.607 lbs.	.164
19.....	143.7 lbs.	1.090	.758	5.499 lbs.	.198
20.....	163.4 lbs.	1.090	.667	6.940 lbs.	.157
Average.....	166.6 lbs.	\$1.110	\$0.672	6.516 lbs.	\$0.171

Table 8 shows an increase of 4.7 lbs. in milk and of .229 lb. in butter fat production when Lot 2 was fed the ration containing roots, but this larger production was attended with an increased cost, milk costing 5.9 cents more per cwt. and butter fat 1.4 cents more per pound on the root feed.

TABLE 9.

Table showing averages of results from Lots 1 and 2 on Root Ration, as against ration without roots.

Lots 1 and 2.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
Roots.....	167.5 lbs.	\$1.101	\$0.665	6.518 lbs.	\$0.171
No roots.....	156.6 lbs.	.965	.620	6.186 lbs.	.156
Difference.....	10.9 lbs.	\$0.136	\$0.045	.332 lbs.	\$0.015

The average from the ten cows in two four-weeks feeding periods shows an increased production of 10.9 lbs. in milk per week, and .332 lb. in butter fat per week on the root ration; this ration, however, costing on an average 13.6 cents more per week. The cost of milk was increased 4.5 cents per cwt., and butter fat 1.5 cents per pound on the root ration.

WEIGHTS.

Average weight of 10 cows at start of root ration..... 991.3 lbs.
 Average weight of 10 cows at close of root ration..... 1005.7 lbs

Average gain per cow in 4 weeks on root ration..... 14.4 lbs.

Average weight of 10 cows at start of ration without roots.. 997.2 lbs.
 Average weight of 10 cows at close of ration without roots.. 1003.1 lbs.

Average gain per cow in 4 weeks on ration without roots 5.9 lbs.

In this case the cows gained without roots as well as with roots, though increase was slightly larger on the root ration.

TABLE 10.

Summary of results of three experiments with 40 cows.

ROOTS.

	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
Experiment 1, 16 cows.....	168.7 lbs.	\$1.064	\$0.644	6.785 lbs.	\$0.158
Experiment 2, 14 cows.....	163.2 lbs.	1.116	.686	6.164 lbs.	.182
Experiment 3, 10 cows.....	167.5 lbs.	1.101	.665	6.518 lbs.	.171
Average for 40 cows.....	166.4 lbs.	\$1.093	\$0.665	6.489 lbs.	\$0.170

NO ROOTS.

	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
Experiment 1, 16 cows.....	162.9 lbs.	\$0.952	\$0.594	6.498 lbs.	\$0.148
Experiment 2, 14 cows.....	152.4 lbs.	.992	.655	5.751 lbs.	.173
Experiment 3, 10 cows.....	156.6 lbs.	.965	.620	6.186 lbs.	.156
Average for 40 cows.....	157.3 lbs.	\$0.969	\$0.623	6.145 lbs.	\$0.159

TABLE 11.

Comparison of results from Table 10.

Average for 40 cows.	Average weekly milk production.	Average weekly cost of ration.	Average cost of milk per cwt.	Av. weekly butter fat production.	Average cost per lb. butter fat.
Roots.....	166.4 lbs.	\$1.093	\$0.665	6.489 lbs.	\$0.170
No roots.....	157.3 lbs.	.969	.623	6.145 lbs.	.159
Difference.....	9.1 lbs.	\$0.124	\$0.042	.344 lbs.	\$0.011

Average per cent butter fat, "Roots," 3.89.

Average per cent butter fat, "No Roots," 3.90.

The per cent of butter fat was practically the same.

The last table gives the average weekly milk and butter fat production, the average weekly cost of the rations, and the average cost of milk and butter fat as taken from the three feeding trials with a total number of forty cows. The table shows that, while on the root ration the cows produced 9.1 lbs of milk per week, or 1.3 lbs. per day more than when receiving no roots, that the butter fat production was increased by .34 lbs. per week, or .049 lbs. per day. The addition of roots, however, increased the cost of the ration by 12.4 cents per week, or 1.77 cents per day, and the cost of milk production on the root ration was raised 4.2 cents per 100 lbs., of butter fat 1.1 cents per pound.

SUMMARY.

Increase in weekly milk flow per cow on root ration:

Experiment 1	5.85 lbs.
Experiment 2	10.75 lbs.
Experiment 3	10.90 lbs.
Average	9.16 lbs.

Increase in weekly butter fat production, per cow, on root ration.

Experiment 1	.287 lbs.
Experiment 2	.413 lbs.
Experiment 3	.332 lbs.
Average	.344 lbs.

Increase in cost of ration per cow for one week, roots added:

Experiment 1	11.2 cents
Experiment 2	12.4 cents
Experiment 3	13.6 cents
Average	12.4 cents

Increase in cost of milk per 100 lbs, when on root ration:

Experiment 1	5.01 cents
Experiment 2	3.10 cents
Experiment 3	4.50 cents
Average	4.20 cents

Increase in cost of butter fat per pound, on root ration:

Experiment 1	1.08 cents
Experiment 2	0.91 cents
Experiment 3	1.50 cents
Average	1.16 cents

CONCLUSIONS.

The addition of roots to an already complete ration of silage, clover hay, and grain, for a dairy cow, stimulated both milk and butter fat production.

The cost of the ration, however, was raised to such a degree as to lessen the profit of production, milk costing 4.2 cents more per hundred pounds, and butter fat 1.1 cents more per pound, as a result.

In case a large production is desired, as in making records, roots might be used to advantage.

The cows gained in weight more on the root ration, than when fed without roots, but the difference was not great.

The percentage of butter fat in the milk was constant, whether on the "Root Ration," or without roots.

